THE OHIO JOURNAL OF SCIENCE

VOL. XLIX JULY, 1949 No. 4

APE OR MAN?

AN INCOMPLETE CHAPTER OF HUMAN ANCESTRY FROM SOUTH AFRICA[1]

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Psychology can no doubt account for the almost morbid interest modern man displays in his ancestors and their humbler relatives. The deader they are, the more fascination they seem to hold for him. Nor is he deterred by finding that some were hanged for sheep-stealing, or eaten for cannibalism. Mere reference to a "missing link" is good for a 96-point news headline at any time.

The particular group of near-relatives whom I wish to present to you this evening are some whose remains came to light recently in South Africa. The finds were made at sites I visited some months ago, thanks to invitations from the Archaeological Survey of South Africa, the University of the Witwatersrand at Johannesburg, the Bernard Price Foundation, and the University of California's African Expedition under Dr. Charles L. Camp, of which I was privileged to be a member.[2] While the fossil finds themselves have received wide notice in the scientific press, much less has been said about their field-setting and the broader problems they involve. These range beyond the confines of the anatomist's laboratory, and call for a concerted attack by geologist, stratigrapher, physiographer, climatologist, anthropologist and paleontologist alike. The critical questions still await precise answers. Perhaps this only makes an interim report of progress the more appropriate at this time.

South Africa, the sub-continent from the Zambesi to the Cape, is a large place—almost half the size of the continental United States. One may think of it as a shield-shaped platform of older deformed rocks, worn down by weather and water to a surface of low relief, and then buried by a thick cover of flat-lying younger layers—mainly sand and silt, glacial debris, and lava. These younger strata—the earliest dating back to the days of the swamp forests which became the Coal Measures of Pennsylvania—take their name from the barren Karroo plateau-land which they build. The distorted older formations on which they rest range from early Pre-Cambrian to Mississippian in age. The whole platform, originally considerably larger than it is today, was buckled and broken down along its southern and south-eastern margin, and faintly warped in the interior. But otherwise it has stood remarkably stable over a span of later geological time measurable in many tens of millions of years—long enough for much of the flat Karroo overlay to be stripped off down to the older foundations, and for the heart of the region to be blanketed with the sand of the Kalahari desert.

[1]Presidential address delivered before the Ohio Academy of Science, at Denison University, Granville, Ohio, April 22, 1949.

[2]I am under personal debt to my Johannesburg host, Dr. Raymond Dart, to the late Dr. Alex DuToit, dean of South African geologists, to Dr. Sidney Haughton, Director of the Geological Survey, to Prof. C. van Riet Lowe, Director of the Archaeological Survey, Prof. J. C. van der Horst and other members of the Bernard Price Foundation, as well as to scientists who guided me in the field—especially Dr. Robert Broom, Dr. B. M. Malan, Dr. H. B. Cooke, and my colleague, Dr. Frank Peabody.

The coast, like that of Europe and North America, preserves in places the etch-marks of wave action and traces of marine veneer which record the fall and rise of sea-level—due either to the refrigeration and melting of the Great Ice Age, or to the slow faint heavings of the Earth's crust. In the extreme south the Cretaceous sea had pushed two long arms inland between flanking ranges, while a brief still earlier incursion of ocean waters formed the shallow Bokkeveld Sea (Lower Devonian). But with these exceptions, virtually the entire area has stood above sea-level since the dawn of the Paleozoic Era.

Thus South Africa has been uninterruptedly "continental" since before forests first appeared on the earth, when primitive fishes were the most advanced form of life, indeed, if we exclude the area flooded by the Bokkeveld Sea, since the days when backbones were still inventions of the future, and the master race on the

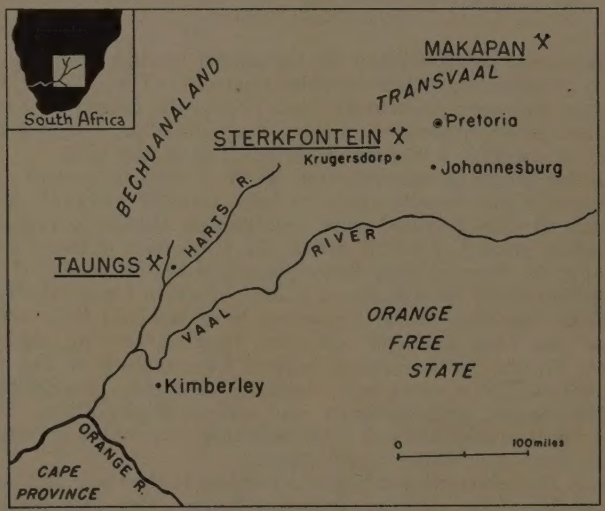


FIG. 1. Location of Australopithecine sites.

planet were the sea-faring molluscs and their humbler relatives. Hence the region offers a chance to find new paragraphs in the fragmental record of what must have been a continuous evolution of land-inhabiting creatures.

A century ago (1856) A. G. Bain first astonished the geological world by finding superb reptile remains in the Karroo strata (1). Others followed in his footsteps. To Dr. Robert Broom goes credit for awakening the government to the scientific importance of these national treasures in the Karroo. It may be interjected in passing that Dr. Charles Camp of the University of California, himself an authority on reptilian fossils, was already familiar with the region, and at the invitation of General Smuts made it a primary objective of his expedition in 1947–1948.

The Karroo reptiles had their heyday, and in due time gave place to four-footed mammals, and these in turn to the rarer two-footed ones of which I speak tonight. The reason for their rarity is obvious. The present era is one of denudation, and when a land surface is being worn down at an average rate of about a foot in 1500 years (2), such perishable objects as skeletons are soon destroyed. Indeed, only when they happen to be deeply entombed, or lodged in a protecting cave or fissure below the general surface of erosion, are they likely to be preserved. Fortunately, in places, the stripping away of the Karroo strata exposed older beds of limestones which, like those of Virginia or the Mammoth

Cave district, dissolve away, leaving caverns that offer a night's shelter to man and beast.

Much of this stripping was the work of the Orange River and its tributaries, of which the most important is the Vaal. This draws its headwaters from the Eastern Transvaal, so that rain water falling within 160 miles of the Indian Ocean may travel 1000 miles across the width of the continent before entering the Atlantic. For 300 miles the Vaal forms the boundary between Orange Free State and the Transvaal, passing within 40 miles of Johannesburg and Krugersdorp before striking southwest to join the Orange River (Fig. 1). Above this confluence, when abreast of Kimberley, it is joined by the Harts River which comes in from the north along the edge of Bechuanaland. A branch of this stream, the Dry Harts, flows between the village of Taungs and the edge of the Kaap plateau, an escarpment of Transvaal Dolomite (late pre-Cambrian) in which a quarry was opened by the Northern Lime Company during the first world war.

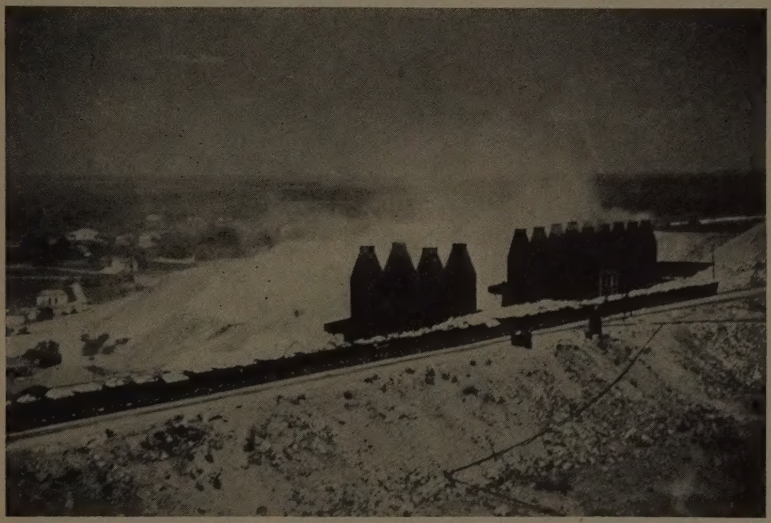


PLATE I. View from the original *Australopithecus* site across Norlim kilms to Dry Harts valley.

From this Norlim quarry in 1924 came a fossil skull, of which its scientific foster-parent, Dr. Raymond Dart, wrote: "The specimen is of importance because it exhibits an extinct race of apes intermediate between living anthropoids and man" (3). The head was that of a six-year old, not of a full grown adult. But Dart drew attention to the human, rather than ape-like, character of its jaw, teeth, eye-sockets and skull contours. Despite these features, however, he was not ready to grant the creature full human status, considering it rather a pre-human type. Other eminent anthropologists were less kind, stressing its sub-human aspects and dismissing "Dart's Baby" as more akin to the gorilla or chimpanzee than to Man. So for a decade *Australopithecus africanus* Dart—the "southern anthropoid from Africa"—had to bide his time on the shelf.

In 1886 gold had been struck on the Witwatersrand—we would have named it the Clearwater Reef—and a string of settlements sprang up overnight on either side of Johannesburg along the outcrop of ore-bearing conglomerate which was to yield 10 billion dollars of the precious metal. The following year, one of these mining camps in the West Rand district, 25 miles from Johannesburg, was named after the president, Paul Kruger. Today Krugersdorp is a thriving town with

sixty miles of tree-lined streets, in the heart of a district which still retains the original names and curiously shaped boundary lines of farmlands granted to the first Dutch settlers. Farther south these farm plats are often circular, being the largest area the first owner could ride round and stake out with stone cairns between dawn and sunset.

Over the lunch table at Pretoria, a leading lawyer told me that as a boy, when his family still owned the farms of Swartkrans and Kromdraai, six miles from Krugersdorp, he used to play bowls on the attic floor with a "stone skull," one of several that had been picked up in the fields. The soil, however, was poor and the Swartkrans farmlands were better known for the Sterkfontein caves in outcrops of the limestone which was worked for the kilns. For half a century, fossil bones of antelope, horses, monkeys, baboons, porcupines, and rats have been picked from the rock debris in the caves. In 1935 the enterprising author of a tourist guide to the district even advised visitors to "Come to Sterkfontein and find the missing link!" In 1936 Dr. Robert Broom did go to Sterkfontein and found the broken skull of *Australopithecus transvaalensis* (4). Later study led him to establish it as a new genus, *Plesianthropus*, though still a member of the same family of Australopithecinae as Dart's original find.

In 1938 another australopithecine, *Paranthropus robustus*, was found two miles away at Kromdraai, thanks to a fossil-hunting schoolboy, who had been carrying round in his trousers pocket four precious teeth—"the most wonderful ever seen in history"—on which Broom at once pounced. In his book on "the South African Fossil Ape-men," Dr. Broom gives a racy account of the events which led up to this and the other finds in the Sterkfontein area, including the way in which he persuaded the school headmaster, in return for a lecture on the importance of caves, to let the boys out early enough for Gert Terbranche, the lad in question, to take him back to the spot before dusk. Since then, more has come from both Kromdraai and Sterkfontein (5). In June of the season I was there, a remarkably human-looking pelvis came to light (6), and Dr. Broom now has fossil parts representing more than a dozen distinct individuals, some betokened only by their share of the gross of teeth that have been collected. In April, 1948, twenty-six pits were excavated by the University of California Expedition at Bolts Farm, a mile from Sterkfontein. From two of them australopithecine leg bones were recovered (7). Finally in December, 1948, Dr. Broom reported the finding at Sterkfontein of the teeth and massive lower jaw of "Swartkrans Man" (8), apparently a related creature, but of distinctly heavier build.

Appropriately named *Paranthropus crassidens* ("coarse-toothed"), with teeth 50 per cent larger than *P. robustus*, the creature resembles in this respect the so-called giant types found by von Koenigswald in Java and known also from South China (9). Thanks to enviable public relations in the weekly press, Swartkrans Man has earned the reputation of a giant. Actually there is no evidence of great stature. The amount of his remains thus far recovered is distinctly limited,—limited in fact to four teeth, firmly embedded in a broken piece of his jaw not over three inches in length. This may suffice to let Dr. Broom's almost uncanny intuition restore the head (10). But it is a trifle risky to let fancy reconstruct an entire animal on the basis of its out-size dentition, mostly missing. The story is told of three agents for competing hair-restorers. The first dropped a bottle on his doorstep in the dark, and awoke next day to find a luxuriant fully grown door-mat. The second had a tabby which failed to give right-of-way to the lawn-mower, and was converted by caudectomy into a Manx cat, a mishap quickly remedied by the use of his magic hair-restorer. The discarded tail was thrown over the hedge. "Oh," said the third man, who lived next door, "I found that tail on the grass, and tried some of our famous restorer. Next morning we had a new cat." Even if reconstructions of Swartkrans Man prove later to be more accurate than the restored feline, it remains true that we had very little of him to start with.

Meanwhile field work had been progressing in Makapansgat valley, 150 miles to the north. A limestone cave had long been famous as the last holdout of the fierce native chief Makapan, whose marauding tribe had attacked Dutch settlers and killed their leader Potgieter. In revenge, the Dutch, after fierce fighting, drove the natives into the cave, filled the entry with a wall of stones and brushwood, set fire to the latter, and virtually exterminated the warriors within. A nearby cave showed signs of earlier occupation, and the Bernard Price Foundation provided funds for a meticulously careful excavation which, in the interval between my first and second visits, yielded Early Paleolithic implements. In the report which I was asked to make on the prospects of further success, it needed no great acumen to confirm the well-founded belief of the scientists of the Archaeological Survey directing the work that here, if anywhere, actual fossil remains of the makers of those stone tools should be found *in situ*. Still, it was satisfying to learn that two weeks later a jaw of Neanderthal type was blasted out of the travertine. I added the hope that excavating would also be resumed in a dis-

PLATE II. Original entrance to Cave of Hearths.

tinctly older cave deposit, at the limeworks a mile farther down the valley, where Professor Dart and his students had previously found fossil baboon skulls of a species associated with Australopithecines in the southern localities. Within a matter of days (September, 1947) Dart reported the finding of an adult australopith occipital bone (11), followed in July, 1948, by an infantile right parietal and an adolescent jaw, and finally last October by a right maxilla and part of the face of a female adult. Australopithecine remains have thus been recovered from dolomite caves in three widely separated localities—Taungs, Sterkfontein and vicinity, and Makapansgat—and further field work can hardly avoid uncovering more.

In the growth of scientific knowledge, the newer finds are often unkindly disconcerting. Where only a few data or single specimens exist, an easy explanation may fit all the known facts. Incomplete knowledge suggests a spurious simplicity. But newer discoveries refuse to fit the theory, and the first hypothesis has to be recast. Some of the certainties of the physics and chemistry of fifty years ago have been placed in the discard by a fissionable atom. For years French

and German anthropologists denied human status to Piltdown Man, if only on the ground that his skull was so thick—a pardonable lapse, perhaps, in view of the fact that he lived in England. But when Peking Man appeared in a North China cave, and proved the owner, not only of an equally thick cranium, but of stone implements and a dead fire on the hearth as well, the status of Eoanthropus had to be reconsidered. It has been so also with *Australopithecus africanus* Dart.

No one questions the claim of the Australopithecinae to accredited membership in the exalted Anthropoid Suborder of Primates to which both men and apes belong. There is more hesitation about accepting them into the family of the Hominidae, which includes our noble selves, *Homo, sapiens* and otherwise, *Sinanthropus* from Peking, *Pithecanthropus* of Java, and *Eoanthropus* from Piltdown. The first point of debate is how many anatomical quality points they had amassed towards graduation into true human status with all rights and privileges appertaining thereto—reading, writing, arithmetic, cannibalism, and atomic destruction. The second question is how close they stood to the ancestral stock from which modern man is descended.

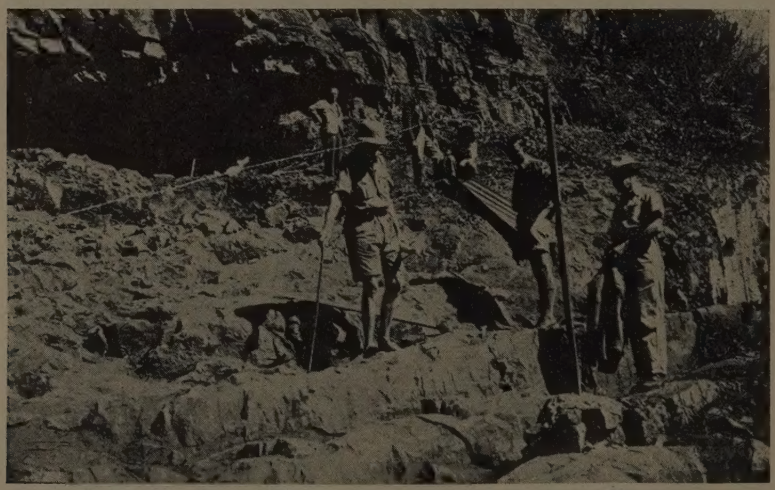


PLATE III. Excavation in progress at entrance to Cave of Hearths.

In any attempt to compare the mental ratings or I.Q.'s of the various primates, the volume and shape of the brain are often useful indicators. Account has to be taken, of course, of the body size, age, and sex of the individual, of the relative development of the different brain sectors, and of the extent and complexity of the convolutions which increase the brain surface without adding to its bulk. Average cranial capacities for the chimpanzee and gorilla are 400 and 480 cc. respectively, with possible extremes of 20 per cent in either direction (Fig. 2). In comparison, *Pithecanthropus* of Java is credited with from 750 to 900 cc. On this basis of skull fragments of 15 individuals, *Sinanthropus* is allowed 915–1225 cc. (average 1040), while *Homo*, ancient and modern, hovers around 1500 cc. but may extend as much as 30 per cent in either direction. For, while the oft-cited Dean Swift had a headpiece of over 2000 cc. and a modern Hottentot in Capetown had one of the same size, Anatole France did very creditable thinking with only 1100, while the great diplomat Leon Gambetta saved France with even less.

Thus while the hominid types range from over 2,000 cc. down to 750, there has existed an unfilled gap between the smallest brained humans and the highest living apes with 520 cc. It is precisely into this "No Man's Land" that the South

African types fall. The two *Plesianthropus* skulls held brains of 435 and 560 respectively, as against 650 for *Paranthropus*. The *Australopithecus* six-year old had a 520 cc. skull, which in view of his premature death is consistent with an adult brain of 700 cc. Of course we know neither the range of variation within each species, nor whether these particular samples were of average brain size for their types. Schepers points out that if the *Paranthropus* specimen was of average cranial capacity, mere normal variation within the species might well involve a range of from 490 to 815 cc. Thus the brains of the australopithecines span the gap between genuine apes and real men. On the basis of skull capacity alone, then, their status as fully human remains a moot point.

On the second issue, it is clear that no living or recent ape can be the close relative of anything but another ape. But going back a million years, the forebears of today's apes and men were less advanced, and perhaps a little closer to each other, as they were nearer to the common ancestor of both lines of descent. Possible closeness to human lineage is therefore directly related to other questions—How long is it since the australopithecines were alive? Did they all live at about

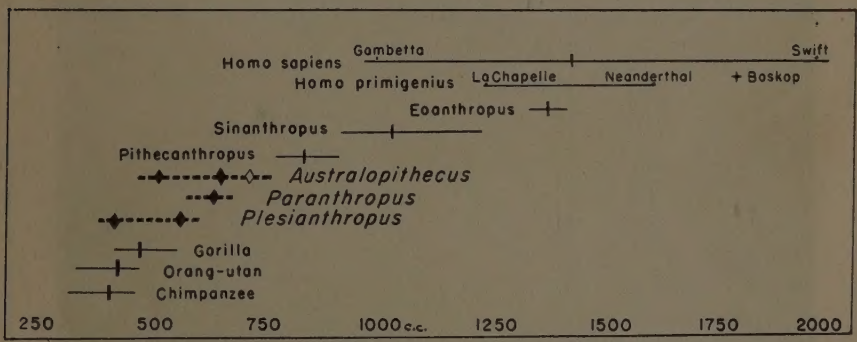


FIG. 2. Actual cranial capacities of Australopithecinae compared with averages and ranges for other primates.

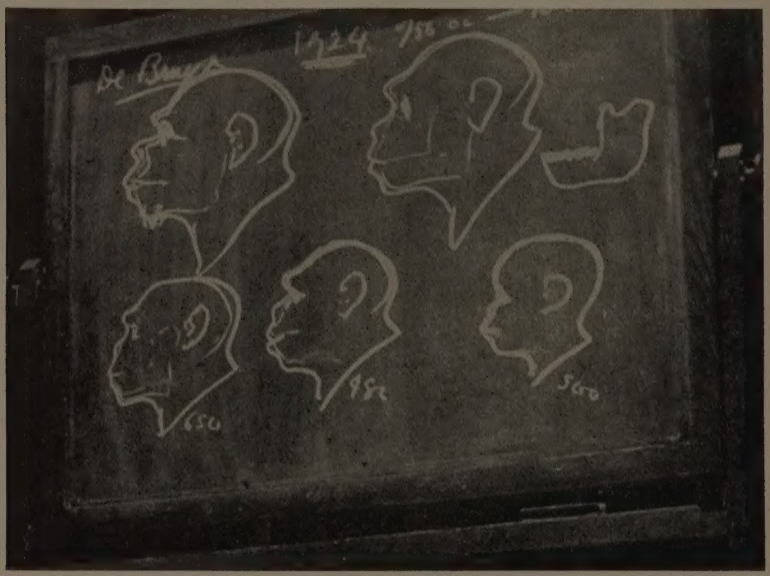
the same time, or were some of them separated by hundreds of thousands of years? Does a study of the setting in which their remains occur suggest anything as to their nature, habits and environment, which a careful study of fossil material on a laboratory table would not reveal? These are the questions the anthropologist asks the geologist and the paleontologist.

But first let us approach the anthropologist. Unfortunately we seem to find him sitting on the fence—though maybe less assured than he was when Dart faced the scientific world almost single-handed with his back to the wall and his "baby" on his arm. Of course, the anthropologist speaks with dogmatic assurance or he wouldn't be a scientist! But maybe I do him an injustice. Perhaps it is he who is putting the australopiths on the fence for our inspection. And having hardly more knowledge about these matters than had Australopithecus himself, I can only quote what comes out of wiser heads than mine.

Dr. Weidenreich, to whom we owe the later precise studies of *Sinanthropus pekingensis*, was in no two minds about *Australopithecus*. In a paper written in 1948 for the volume commemorating Dr. Broom's eightieth year, he admits the human appearance of the dentition and other features but considers that the shape of the brain is simian, and concludes that the puzzling humanlike features these creatures show were holdovers from the past, rather than anticipations of the future. "In other words, the features they share with man are those retained from an original stock when they, like typical anthropoids, acquired special differentiation. These led them away from the hominids whose differentiations

went in other directions" (12). When I spoke with Dr. Weidenreich in New York a few days before his death last July, he said he had seen nothing to change this opinion.

Professor LeGros Clark of Oxford, dean of British anatomists, takes a less extreme position. In New York last June he stated his opinion (i) that the ten skulls of which parts had then been found are all of animals belonging to the same group, (ii) that they show certain features which distinguish them from typical apes (*e.g.*, the absence of the gap next the incisor teeth which characterizes the latter), (iii) that their original owners were ape-like creatures with some hominid features that are closer to man than to apes, and (iv) that there is nothing in their morphology that would prevent their being ancestral to *Homo sapiens* (13). Others who, at first cautious, are now ready to accept *Australopithecus* as already human include Adloff, Kleinschmidt, Sollas and Von Koenigswald.



Homo neanderthalensis *Pithecanthropus erectus*
Paranthropus robustus *Plesianthropus transvaalensis* *Australopithecus africanus*

PLATE IV. Blackboard sketches made by Dr. Robert Broom at American Museum of Natural History of cranial outlines and facial reconstructions of Australopithecine and higher hominid types.

Reference was made to the human appearance of the pelvic bone found by Broom at Sterkfontein. I saw it lying on his table between the corresponding bones of a chimpanzee and a modern Zulu woman (6). The resemblance to the latter, and the entirely different proportions of its chimpanzee counterpart, were so glaringly obvious as to be beyond dispute. The later finds at Makapansgat led Dart to break up and examine carefully every block of breccia and fragment of bone in the ten tons that had come to the laboratory from the 600 tons on the cave dump—a long task, not yet completed. He thus recovered odd teeth, bits of limb bones, a left ilium and a right ischium, which fully confirm the evidence of the Sterkfontein pelvis by proving even more human-like (14). But although these features strengthen the apparent close relationship to modern man, direct descent is another matter. For since man was certainly living on the earth by very early in the Pleistocene Period, the australopiths can be the progenitors of

modern man only if the Sterkfontein fossils date from the Pliocene Period, unless, indeed, more than one race of men evolved independently in different centres. Hence the need to fix the geological age of the breccias on some other basis.

Australopithecus himself then, lying silent on the laboratory table beside the other primate skulls, refuses, sphinx-like, to answer the question, and winks at the geologist, who goes discreetly back to his cave to look for clues of other kinds. The cave-deposits yield fossil bones of quite a range of other animals. If these can be shown to have lived at the same time as Australopithecus, and if their geological age is exactly known, the deposit may be dated. Failing these, the character of the cave-filling itself might be linked to climatic changes related to such widespread fluctuations as those which went with the onset and waning of the glacial stages of the Great Ice Age. Yet again, the opening up and subsequent filling of the caverns is related to landscape changes—especially those con-

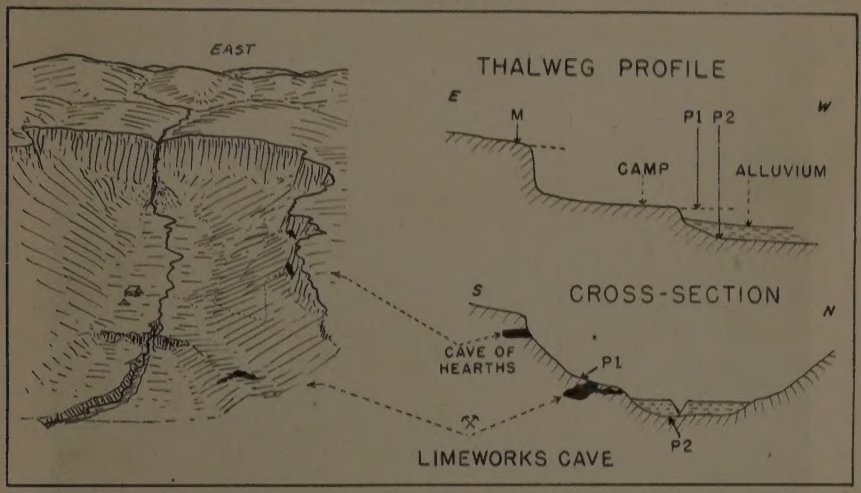


FIG. 3. Generalized Physiographic Diagram and projected Profiles of Makapansgat Valley.
Showing position of Limeworks and Cave of Hearths relative to erosion surfaces M, P1 and P2.

nected with the past history of the rivers, the widening of the valley floors, and the wearing back of the hill slopes. If no single approach gives a certain answer, several may combine to set limits to the antiquity of the creatures embedded in the cave-filling.

The geological age of the fossil-bearing deposits may first be fixed within broad limits and thus clamped, as in the jaws of a vise, between an earlier and a later date. As the gap is narrowed, the dating becomes more precise. Since neither the creatures nor their fragile remains could get into a fissure or cave before it was opened to the air, they cannot have roamed the land till *after* the limestone was first exposed by erosion. But this occurred well before the close of the Tertiary Era, which leaves the lower limit sadly loose and far-extended. In the other direction, the bedrock and its cave fillings had been bevelled off to a smooth surface by erosion *before* the streams gained enough fresh energy to incise it again. Therefore the cave fillings were already there at least before the penultimate life cycle of the streams. Fig. 3 shows the sharply discordant relationship between the steep slopes of the Makapansgat valley and the older low-relief surface of the upland it incises. The bench bevelling the Limeworks breccia is a remnant of the

P-1 surface which is preserved in the valley head. Downstream from the camp-site knickpoint, this surface has been almost entirely destroyed by a later erosion cycle (P-2). Since then, the rock-floor of the valley has been buried under a ten-foot cover of alluvium and surface wash, and is only exposed where cut through by recent stream action. (Somewhat comparable features may be seen in many of the valleys of southern Ohio, where branches and terraces along the base of the hills provide strips of flat ground, much appreciated by railroad engineers and road builders since they stand well above flood-level when the fields on the valley bottoms go under water. But these farm-studded platforms are built of sand and gravel, hastily dropped by glacial meltwater, whereas the occasional tell-tale benches of South Africa had to be sculptured over a much longer time from solid rock.) On grounds which range farther afield than we can roam tonight, the final shaping of that lost landscape (P-1) at Makapan can hardly be much younger than Lower Pleistocene.[3] Consequently, the cave-fillings must be of greater age.

PLATE V. Camp, Dart and Haughton, in Makapansgat Valley.

Even this still leaves the time gap unhappily wide. Further field studies will undoubtedly cut it down.

Meanwhile the cave-deposits themselves throw further light on the problem. Whereas with surface sediment dropped by rivers the top layer is more recent than what lies below, any visitor to Mammoth Cave finds a whole network of galleries at different levels, connected by vertical chimneys or sloping chutes. A fissure extending to the surface may fill with debris, funneled down from above almost as soon as it is breached. A roofed cavern may fill more slowly, partly with

[3]Several factors conspire to make close dating of the Pre-Pleistocene erosional surfaces in South Africa peculiarly difficult. Almost the only Tertiary datum-level of any extent is that set by the Alexandria Limestone and its equivalents along the south-east coast, which have a marine fauna allied to that of Miocene-Pliocene age in Europe. Surfaces related to this and other Tertiary raised beach levels are hard to trace, (1) because prolonged uninterrupted denudation has destroyed the older landforms over wide areas, (2) because profiles run into the interior have to be carried over immense distances over varied structures which make the use of knickpoints and kindred tell-tale features unreliable as criteria of rejuvenation, and (3) because the attention to development of natural resources has left little margin of time and energy for geomorphic studies on the part of the competent but small group of qualified geologists available in so vast a region.

stalagmites and wall coatings left by evaporating limewater dripping from the ceiling, partly with sand and silt washed in by underground streams, and partly with fallen roof rock. As the roof collapses, both floor and ceiling are raised, and the cavity migrates upwards. Once filled, a cave site may be partially reopened by solution and even refilled a second time. Thus two caves in a single locality may have quite different histories. In Locality 1 at the Peking Man site, the infilled material was over 180 feet in depth and represented three distinct epochs of accumulation. One zone 25 feet deep formed an indivisible unit, all deposited in a brief space of time. Another just above it, only 17 feet thick, had 100 separate layers,—black, red and yellow from the hearth-fires of repeated human occupation. Caves and their contents are therefore capricious things, often guilty of deceitful underground behavior which may mislead the unwary.

Unlike the other Australopithecine sites, the classic Taungs locality was not a cave. The fossils occur in a pink breccia of rock fragments choking fissures in an immense platform of travertine. This platform was built out in irregular sheafs of fluted curtains, festoons and cauliflower-like growths, round the outlets of long-dead springs in a notch of a Transvaal dolomite escarpment at the edge of the Kaap Plateau (Plate I). Animals that came to drink and lost their footing, or died on the slopes above, were washed into open crevasses and pockets, along with sand, gravel, and coarser rock debris. In time, the spreading growth of travertine had advanced 1200 feet from its earliest position. Enough accumulated to keep the battery of Norlim lime-kilns running full blast for two decades. Hence its period of growth must have spanned some tens of thousands of years. The individual breccia-pockets are sometimes roughly layered but, except that the lower rear parts of the deposit are older than the front upper parts, the structure offers little on which to base a stratigraphic sequence. However, its upper surface is pitted with solution pockets choked with red-brown earth, obviously dating from a later epoch of different conditions. This brown earth is criss-crossed with white veins of calcite, and sometimes contains late Paleolithic stone implements and even layers of ash, charcoal, and burnt bones. Right on the surface we picked up dozens of small stone flakes, identified by Dr. van Riet Lowe as belonging to the Smithfield and Wilton microlithic cultures, corresponding to Aurignacian and Magdalenian types of the later Old Stone Age of Europe.

Six months of excavation (1947–1948) by the University of California Expedition at some 30 sites along the edge of the Kaap plateau on either side of Taungs produced no new australopithecine material but had other results of importance. In many places the pink breccias yielded fossils of his contemporaries, including baboon skulls of types found at Sterkfontein and Makapan. And at a number of sites, beneath the pink breccia, Dr. Camp's party found an older grey breccia, with remains of horse and antelope, invariably *sans* baboons (15). Along the face of the escarpment there are open caves of still younger date, some with Middle Stone Age implements sealed in the floor where Man dropped them, others with even more recent artifacts showing Bushman techniques. But until the fossils from the two breccias have been studied and compared with those from other sites, we can say only that as far as Taungs is concerned the pink Australopithecus-breccia is distinctly *younger* than the moister days with horse and antelope of the gray breccia, and considerably *older* than the brown earth pockets of late Pleistocene days when human culture had already advanced through several stages.

In the Krugersdorp district and at Makapan we are dealing not with surface crevasses and pockets in spring deposits, but with true cavities in bedrock. The rock at the Sterkfontein, Kromdraai and Bolts Farm sites is Transvaal Dolomite, essentially the same formation as at Taungs. At Sterkfontein, the caves follow two main fissure systems which run north down the dip of the strata. In the spot where *Plesianthropus* was first found, the character and position of the material now occupying what once was a cave argue against its having been used as a lair by animals. The filling is mainly of boulders and rock fragments of all sizes in a

matrix of terracotta sand, well cemented with lime. Much of the rock debris had been weathered above ground level before falling into the hole along with blocks of roof-rock. No stratification can be detected, though the lower part of the mass is on the whole coarser and freer from fossils, while broken bones become increasingly abundant in the upper, finer portion of the breccia. This distinction between a lower and an upper zone is seldom abrupt, but follows an inclined surface, as if the whole mass involved successive slumping on the side of a heap or talus. It is probable, therefore, that, except for rodents, bats, and other small cave-dwellers, the fossil material, like the bulk of the deposit, was funneled down from the surface.

For caves to form, moisture is necessary. But climates fluctuate. In places, the breccia is separated from the bedrock by a pavement or wall-coating of travertine. Further, according to Cooke (16), the sandy matrix of the breccia has much less chert and quartz in proportion to carbonate than exists in the soil on the hill slopes today. This suggests that the climate when the cave was filling

PLATE VI. Dolomite caves in Makapansgat Valley.

was *drier* than that of today, thus leaving a greater percentage of dolomite unleached in the soil than occurs under present conditions.

This is the same sequence of climatic fluctuations as was noted at Taungs, where the formation of the pink breccias was both preceded and followed by conditions of greater moisture. Haughton has pointed out that the observed facts call only for (a) a moist period to account for cave and fissure solution, (b) a semi-arid epoch to explain the angular dolomite fragments with weathered crusts, and the red sandy matrix, (c) a period of renewed moisture to cement these into travertine, and (d) the period of renewed erosion which bevelled the bedrock and incised the valley of the Vaal and its tributaries (17). (This generalization refers to the climatic fluctuations during the critical interval between formation of the cavities and the time when the fossiliferous breccia choking them suffered the same surface reduction that affected the entire region. Haughton was concerned neither with the earlier erosional stages which first exposed the limestone, nor with the clearly marked episodes which punctured the later history of the drainage system of the area.)

It would of course be highly significant if the inferred sequence of climatic

fluctuations could be shown to tally with more widespread changes such as those which caused the successive advances and retreats of the Pleistocene ice-front in Europe. Though East Africa has several volcanic peaks within a degree of the Equator with active glaciers on their flanks today, there was no Great Ice Age in South Africa. But the arid stage in the wet-dry-wet sequence must have swept an increased volume of sand and loess into the lee sector. Bosazza believes he can identify four distinct invasions of desert conditions during and since the Pliocene, one of these being attested by a mantle of red sand and loess along the Harts near Taungs (18). But though the stages of Alpine ice advance have been correlated with climatic and sea-level changes recorded well outside the glaciated areas on both sides of the Mediterranean, we still know too little as to just how closely these tally with events further from the ice centers. One might argue that each epoch of renewed erosion in, say, the Kharga Oasis of Egypt meant heavier rainfall; and that these correspond exactly with the times when, in more northerly latitudes, increased precipitation brought the snow which became the ice. But the

PLATE VII. Excavation at Sterkfontein site.

climatic controls governing the spread of ice conditions are still too poorly understood for it to be safe to equate pluvial conditions in Kenya with glacial stages in the Alps, still less to link the spread of the Kalahari desert with inter-pluvial or interglacial stages on the other side of the Equator.

The growth of the Pleistocene ice-caps withdrew from the ocean enough cubic miles of water to lower sea-level on every coast around the globe. With each such marine retreat, rivers had to entrench their channels, first at their mouths, and then progressively upstream. But shifts of standline may result also from purely local disturbances of the Earth's crust. And until these have been ruled out as a possible cause, we dare not assume that any particular ancient sea-beach, standing today at, say, 600 feet above sea-level, records the highwater mark of a particular interglacial stage. Correlation is made harder by the fact that in any case most of the older beaches have been warped from their pristine horizontal position. The S. E. coast of Africa has excellent raised beach lines and progress is being made in unravelling these frayed edges of the record. But as yet it has not been extended back to the time when Australopithecus was alive.

So thus far neither inferred fluctuations of climate, nor sea-level shifts traced by knickpoints up the rivers, give criteria of the definiteness needed to fix the particular geological dates in question.

There remains the paleontologist's line of attack—that of correlating animal fossils found in the australopithecine breccias with their dated equivalents elsewhere. The faunal assemblages at the Taungs, Makapan and Krugersdorp sites all belong to the same general epoch of geological history. But like the slightly younger Peking Man fauna, they occur in an isolated region, far from the nearest place where precise age-determinations have been possible. Furthermore, the assemblages at the various sites show differences greater than can be explained by immediate environment or mere chance. It is clear, as might be expected, that they are not strictly contemporaneous, and represent a span of time measurable perhaps in thousands of years, if not more. Thus Sterkfontein has yielded—to mention only a few types by their common names—sabre-tooth tiger, roan antelope,

PLATE VIII. Quarry face at Norlim Limeworks, showing dark pockets of fossiliferous breccia.

reed-buck, wildebeest, a small jackal, several species of baboon, golden mole, elephant-shrew, rats and other rodents. Bolts Farm produced a host of mammals, including the same shrew as at Sterkfontein, but a larger golden mole, a different sabre-tooth, besides fossil pig, a single elephant tooth which may prove significant, and other types not as yet found elsewhere. Kromdraai on the other hand has some of the same animals, but lacks both sabre-tooth and pig, while its baboons are of a different species from those at Sterkfontein. On this account, Broom considers *Paranthropus* from Kromdraai to be geologically slightly younger than *Plesianthropus*. From Makapan, Dart reports two species of baboon found also at Sterkfontain, lion, hyena and jackal, two extinct pigs, rhinoceros, hippopotamus, two extinct relatives of the giraffe, and fourteen types of *Bovidae*, eight of them new to science. None of the Taungs creatures were forest dwellers, several being definitely desert forms. Both Makapan and Taungs have types not found at Sterkfontein or Bolts Farm, but there is enough in common for the four sites to be regarded as of approximately the same geologic age. The assemblage as a whole shows affinities with the Villafranchian fauna of Northern Italy.

A single discrepant element is the presence at Sterkfontein of *Lycyaena silberbergi*, a hyena-like animal closely resembling one found in the Lower Pliocene of Europe and Asia. Until further study has established a more certain affinity, it is unwise to place too much weight on this single animal, which may, after all, have lived on in Africa long after his European and Asiatic cousins had become extinct.

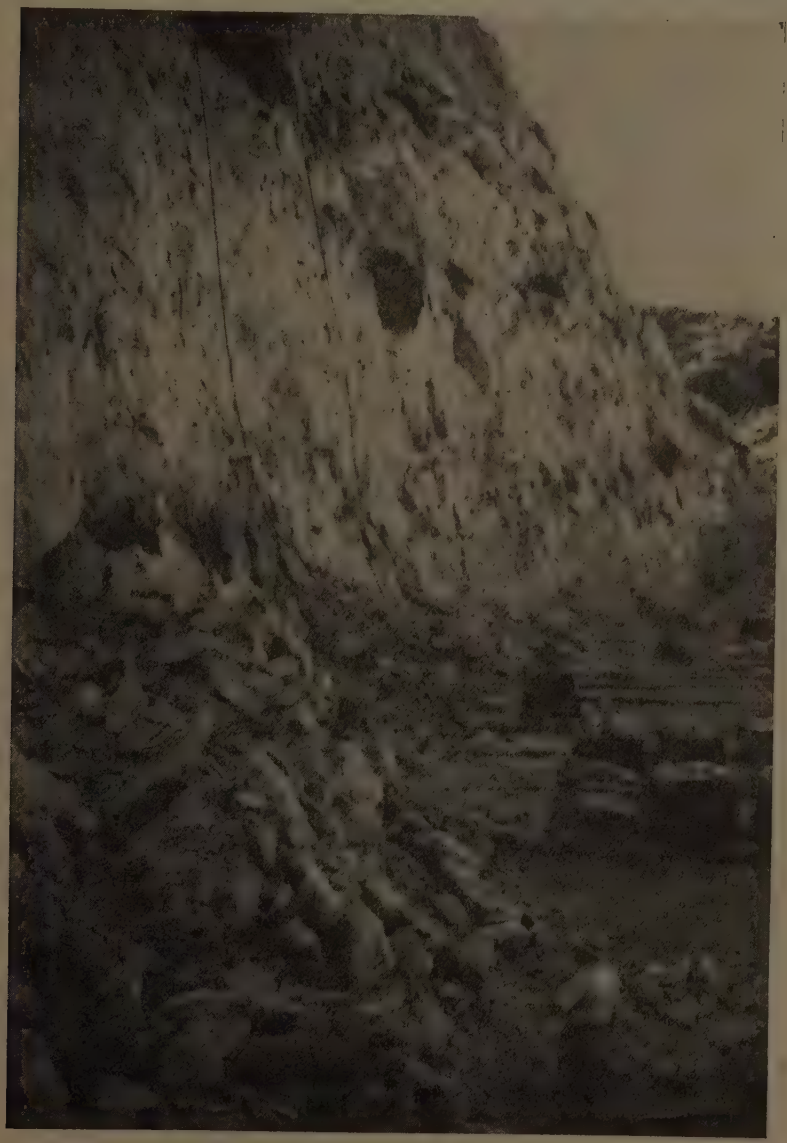


PLATE IX. Fossil hunting in blasted rocks at Taungs site.

Stratigraphic opinion is divided as to the exact place of the Villafranchian with respect to the Plio-Pleistocene boundary,—depending on whether the latter is to be set by the first symptoms, the main onset or the approach to culmination of the first glacial advance, the shift of sea-level, or the resulting changes in fauna, marine or terrestrial. The question was thought worthy of a special section in the XVIII International Geological Congress last summer in London, where a mass of evidence was presented in favor of various period-markers. Some authorities have placed both the Villafranchian and the succeeding Calabrian epochs in the Pleistocene. Others would have the boundary separate the two. As far as the Eastern Hemisphere is concerned, the most satisfactory solution is that of Gignoux which leaves both in the Pliocene, a conclusion supported by Pilgrim (19) on the basis of faunal assemblages in Europe and Asia. Zeuner (20) has attempted to correlate the arguments from this and other lines of evidence. Using the latest data of Milankovitch (21) on climatic fluctuations, he places the lower boundary of the Pleistocene 600,000 years ago. American geologists favor a somewhat earlier date for the dawn of the Great Ice Age on this continent. And yet, maybe the exact hour of dawn is more a matter of local point of view than a source of concern to Australopithecus himself, for on any reckoning, he seems to have been living a full million years ago.

We have looked at our extinct friends from a wide variety of angles—namely, those of the anatomist, anthropologist, geologist, physiographer, stratigrapher and paleontologist, and perhaps are left with the feeling that nothing has been achieved except to shed a flood of inspissated darkness on a cloud of confusing uncertainties. Yet the evidence from these various lines of approach seems to be closing in on the figure of a primitive human, barely emerging from his anthropoid background, who stepped out from the shadows into the sun on the South African veld about the time when the ice sheets were starting to push down across Canada and Northern Europe. Each new piece of evidence from whatever source has to be fitted into the new jigsaw puzzle. Thus *Australopithecus prometheus* was given his second name because microscopic and chemical study of apparently burnt animal bones strongly suggested the use of fire—as proved the case with Peking Man. Some have criticized Dart for leaving out the question-mark he originally placed before the word "(?) Promethean" (11). What matter a few specks of carbon black? And yet, one other curious feature was noted by Dart (22) long before the recent discoveries. A high proportion of the fossil baboon skulls had been crushed in, as if by a severe blow, carefully aimed from the front. Admittedly an occasional ape might have walked in a cave exactly where a piece of roof-rock was about to fall on his cranium. But it was hard to account for the number of cracked skulls assembled on Dart's laboratory table from different localities, several with the same peculiar double-dent trade mark, as if struck with the leg-bone of an ox or some other large animal. It seemed no easier when Dr. Peabody found the same condition in half a dozen more baboon skulls unearthed at Taungs. Careful study showed that 42 out of 58 crania of *Parapapio* from the three *Australopithecus* sites showed the same feature. The blows struck were deliberate and meant to kill. Furthermore, the blows not aimed straight from the front were preponderantly struck at the left side of the head, as if by a right-handed individual! (25). Granted a verdict, not of "death by misadventure," but of "baboonicide," there is of course the question that was raised in the parallel case of "Humanity v. Peking Man"—Is it possible that Australopithecus, like Sinanthropus, could try to plead "Not guilty," by blaming some other higher primate who shaped the crude stone tools we found in the cave at Choukoutien, but who was clever enough to hide his own skeleton? All one can say is that as yet there is no evidence pointing in that direction, even Swartkrans Man being an Australopithecine himself.

The fractured adolescent mandible from Makapansgat (23) corroborated previous evidence (24) that the Australopithecinae not only were carnivorous hunters of large and small game, but were cannibalistic and killed one another with stones, wooden clubs or bone bludgeons. An account of lethal injuries inflicted upon the crania of baboons found at Taungs, Sterkfontein and Makapansgat has recently been published by Dart (25). A letter just received from him adds that the Makapan breccia has now also yielded evidence of a bone and horn culture, little, if at all, different from that which l'Abbe H. Breuil claimed as characteristic of Peking Man.

Presidential addresses possess one great advantage, alike for the pride of the perpetrator and for the comfort of his long-suffering audience—for, like the motion to adjourn, they are not debatable.

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THE HELMINTHS FROM A HEAVILY PARASITIZED FOX SQUIRREL, SCIURIS NIGER

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Usually tree squirrels harbor relatively few helminths per individual but as shown by Rausch and Tiner (1948), the variety of parasites which may be encountered in these hosts is considerable. Generally the fox squirrels which the senior author has examined from this community have been negative for helminths, however, an adult female, which was shot near Ashland on September 27, 1943, was an exception.

One immature specimen of *Macracanthorhynchus hirudinaceus* (Pallas, 1781) was found in the body cavity. It was attached to the inside left flank, and the tissues about the site of attachment were necrotic.

Two female *Rictularia*, possibly *R. onychomis* Chuckler, 1939 were removed from the small intestine. The tails of these ♀ ♀ were shorter than those described by Chuckler. In view of the questionable specific diagnosis the following brief description is given. Length, 40 mm.; combs and spines, prevulvar 29 and 31; postvulvar 31 and 32. Vulva 0.15 mm. cephalic to end of esophagus; esophagus 4.9 mm. long; nerve ring at 0.39 mm. from cephalic extremity. Stoma 0.087 mm. deep and 0.09 mm. wide; tail 0.25 mm. long. Eggs 39 μ by 24 μ.

Eight *Moniliformis clarki* (Ward, 1917) were taken from the small intestine. One of these, a female specimen, was 35.5 cm. long and weighed (wet) 2.2 grams.

Twelve tapeworms were found in the same habitat as the thornyheads. These appear to represent a new species which is described as follows:

Choanotaenia sciuricola n. sp.

The strobilae measured up to 30 cm. when fully relaxed and before fixation. After preparation for microscopic examination a specimen measured 25.5 cm. long and 2.64 mm. wide. The scolex is 0.26 mm. long and 0.32 mm. wide at the level of the unarmed suckers which are 112 by 78 μ. The rostellum is 71.9 μ wide and 184.3 μ long. Twenty-two rostellar hooks are arranged in a single crown. They are very slender and 38 μ long; the handle being 24 μ and the blade 14 μ long.

The long distinct neck is 0.123 mm. wide. The segments are at first wider than long, but the mature segments are about as wide as long. They measure about 1.6 by 1.9 mm. The genital pores are irregularly alternate and are located near the cephalic margin of the proglottid. The cirrus pouch is small and slender measuring 150 to 130 μ by 31 to 38 μ. It extends mesad, in extreme cases, as far as the excretory vessel but usually falls short of that structure. Only one pair of excretory ducts, apparently the ventral pair, could be distinguished either in sectioned or entire material. The cirrus is unarmed. The vas deferens serves as a seminal vesicle. The testes, which are confined to the caudal portion of the proglottid are 29 to 41 μ in diameter. In 49 segments the number of tests varied from 27 to 37, mean 31.1, standard deviation 2.2. One segment, not considered in the above mean, contained 43 testes. The ovary is small, indistinctly bilobed and placed about the middle of the proglottid. The vagina runs caudal to the cirrus pouch and the coiled vas deferens. Near the middle of its course is an enlargement which serves as a seminal receptacle. The uterus extends cephalad of the ovary at first. It is thin walled and soon breaks down.

The gravid proglottids are much longer than wide. The eggs are scattered singly throughout the areolar parenchyma. The embryonic hooks are 18.5 μ long, the embryo is 54.7 μ in diameter and the eggs are 59 by 68.5 μ.

Locality: Ashland, Ohio, September 27, 1948.
Host: *Sciurus niger*.
Habitat: Intestine.
Specimens: Type U. S. National Museum Helm. Col. No. 41496. Additional material in the author's collections.

Comparisons: *Thominx arcuata* agrees with the genus Diagnosis given by Fuhrmann 1920 except for the absence of the dorsal pair of excretory vessels. Therefore this nematode is referred tentatively to the above genus although similar worms from rodents have been referred heretofore to other genera of questionable position.

Thominx is a large genus, but fortunately 10 of the species are easily distinguished from *T. arcuata* by the number of the hooks on the rostellum. The remainder are compared below. *T. alia* Lamborne, 1949 *T. sonnipora* Jorgen

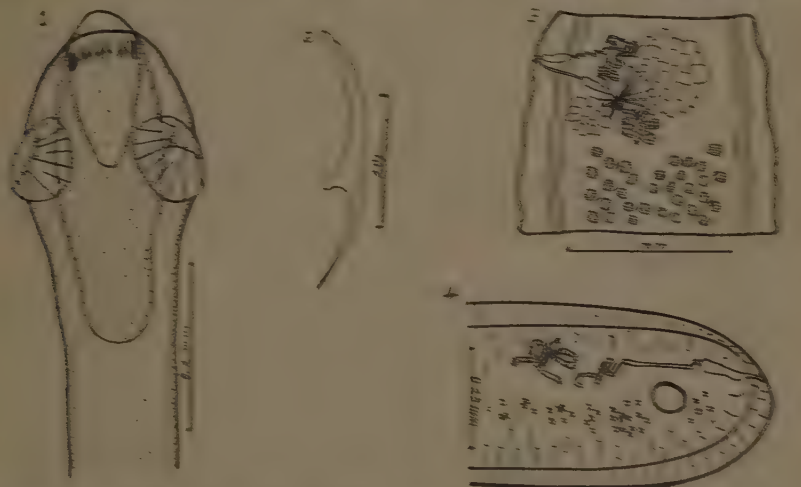

Fig. 1. Scales of *Thominx arcuata*. Fig. 2. Hook from rostellum of *T. arcuata*. Fig. 3. Mature segment of *T. arcuata*. Fig. 4. Cross section at level of cervix pouch.

and Baer, 1950; *T. multispiculum* Johnston, 1913; *T. turneri* Johnston, 1912; and *T. whitemanae* Fuhrman, 1908, all have fewer than 24 testes. On the other hand *T. marshalli* Mola, 1907 and *T. bringer* Jorgen and Baer, 1950 have more numerous testes (50 to 90). In *T. magnisomum* Baer, 1940 the handle of the rostellar hooks is only one-half as long as the blade. The hooks of *T. macrocalibis* Fuhrman, 1907 are extraordinarily long (110 to 145 μ).

T. arcuata resembles *Prochoanoscamia perarmata* Erasmus, 1958 more closely than other forms described heretofore. The rostellar hooks are longer in *Thominx arcuata* (88 μ against 82 μ) although the soldiers are about the same size. The proglottides of the present species are much larger and the testes are more numerous. On the other hand the cirrus pouch is much smaller in *T. arcuata*.

Discussion. Unfortunately the senior author has not recorded the results of every fox squirrel which he has examined; consequently the incidence of parasitism in the animals examined cannot be given exactly, but only one out of 8 or 10 squirrels was found infected with any helminth.

The occurrence of *Macracanthorhynchus hirudinaceus* in a fox squirrel from Ashland County seems peculiar since the parasite is rare in swine raised in this area.

However, the parasite has been reported previously from this host by Rausch and Tiner (1948).

The same writers report finding a *Rictularia* sp. in two of 94 fox squirrels examined by them and Katz found the same parasite in one of 16 fox squirrels which he examined. All were from western Ohio.

Rausch and Tiner (1948) state that *Moniliformis clarki* is uncommon in midwestern sciurids, but Chandler (1947) reports it from other areas. Contrary to Rausch and Tiner, this parasite may be common in the fox squirrels of Ashland County, since hunters have brought this large worm to us for identification on several occasions. However, in animals which have been completely examined for helminths, we have found it only once.

Two squirrels were shot at the edge of the same corn field on September 27. One, an adult female, was heavily parasitized, and weighed 740 grams; the other, an immature female, weighed 710 grams, although obviously much smaller. The tail of the immature, unparasitized female was two inches shorter than that organ in the adult. When the 23 helminths had been collected from the adult female, they weighed in the fresh state just 30 grams. Therefore, the adult squirrel, though of larger body, weighed no more than the helminth-free, young female.

The adult female was shot at 4:30 P.M., the immature at 5:00 P.M. At 8:00 P.M., after both squirrels had been dressed and examined, it was noted that rigor mortis was pronounced in the carcass of the young animal, but that of the adult was still flabby. Since helminths parasitic in domestic animals upset the carbohydrate metabolism of their hosts, this observation may possibly be of some significance.

SUMMARY

Four species of helminths were found in a fox squirrel, *Sciurus niger*, shot near Ashland, Ohio. One of these, *Choanotaenia sciuricola*, represents a new species.

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A Textbook of Entomology

The author of this book departs somewhat from the usual presentation of information for the general or beginning entomology textbook. Chapters on growth and history of the development of entomology and paleontology have been added as well as a separate chapter on physiology. The keys to order and family are not intended to be all inclusive and therefore will accommodate only the common members of the more important families of insects. The content of the book is as follows, by chapters: Growth of North American Entomology; Arthropoda: Insects and Their Allies; External Anatamy; Internal Anatomy; Physiology; Life Cycles; Orders of Insects; Geological History; Ecology; and Control. Selected references are given at the end of each chapter and also for each order of insects.

The book is well illustrated with many new figures. It is an excellent addition to our gowing list of general entomology textbooks and undoubtedly will be widely adopted for use by many colleges and universities.—*R. H. Davidson.*

A Textbook of Entomology, by H. H. Ross. John Wiley and Sons, Inc., New York. 532 pages, 434 figures, 1948. $6.00.

THIONYLDIACETIC ACID[1]

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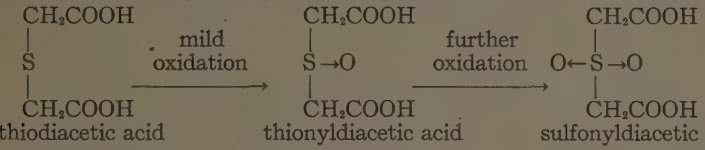
INTRODUCTION

Thionyldiacetic (thionydiglycolic) acid can be classified as a sulfoxide, being derived from thiodiacetic acid by mild oxidation of the sulfur atom present. Stronger oxidation or continued oxidation produces the more stable sulfone. The relationship existing among these compounds can be shown as follows:



In 1909, Gazdar and Smiles (1) prepared thionyldiacetic acid by dissolving thiodiacetic acid in excess hydrogen peroxide (concentration not stated) and allowing the solution to stand at room temperature for forty-eight hours, followed by evaporation of excess water. The sirupy residue became solid, they state, on being kept under diminished pressure over sulfuric acid. Their product, which was "evidently pure," melted at 79–80° C. An analysis for carbon and hydrogen agreed reasonably well with the theoretical value but neither a sulfur analysis nor an equivalent weight determination were reported. In 1923, Jonsson (2) prepared this compound in a similar manner, though he dissolved the thio acid in acetone prior to addition of 30% aqueous hydrogen peroxide in excess. After an evaporation in vacuo, the crystalline mass was washed free of impurities with ethyl ether. His product melted at 119° C. Finally, Larsson (3) reported, in 1940, that he obtained thionyldiacetic acid by the oxidation of thiodiacetic acid using bromide water. His yield was low and the product melted at 109° C. It is evident from these conflicting records that the identity of thionyldiacetic acid cannot be considered as definitely established. This investigation was undertaken to evaluate various methods that had been reported for its preparation and to study its physical and chemical properties. It appears likely that the lack of agreement in the literature regarding this compound resulted, at least in part, from its unstable nature, and therefore all possible precautions were taken to insure a minimum amount of decomposition.

METHODS OF PREPARATION

Literature references relative to the preparation of sulfoxides indicate that they are most conveniently obtained by mild oxidation of the corresponding sulfides. In general, 30% hydrogen peroxide has given excellent results (4), although other oxidizing agents including nitric acid, chromic acid, potassium permanganate, the halogens and perbenzoic acid have been successfully used. In this paper, investigation has been limited to the oxidizing effect of hydrogen peroxide, nitric acid and potassium permanganate upon thiodiacetic acid.

The studies of Gazdar and Smiles and of Jonsson were repeated first, since in both instances the favored reagent, hydrogen peroxide, had been used. A 25-gram sample of freshly prepared thiodiacetic acid was dissolved in 30 ml. of 30% hydrogen peroxide and the solution allowed to stand for 48 hours at room temperature.

[1]Presented at the meeting of the Ohio Academy of Science, Toledo, Ohio, on May 7, 1948.

[2]Presented as a thesis in partial fulfillment of the requirements for the Master of Science degree.

Evaporation in vacuo over sulfuric acid yielded 3 grams of solid product, slightly yellow in color and melting at 100–105° C. Upon washing the product with small amounts of ice-cold acetone, it became pure white and melted sharply at 119° C. (corr.) with decomposition. A quantitative analysis yielded 19.37% sulfur (calculated value for thionyldiacetic acid, 19.29%) and an equivalent weight determination was found to deviate less than 1% from the calculated value of 83.1 for the desired dibasic acid. The yield, using this procedure, was only 11% of theoretical, and it was noted that considerable heat evolved when acid and peroxide were mixed. Moreover the yellow solid showed the presence of rather large amounts of sulfate ion as an impurity.

Repetition of the above procedure except for cooling of the reaction flask in crushed ice as the reactants were mixed, yielded 7.5 grams (27% yield) of white product melting at 119° C. and showing only traces of sulfate ion. Several more trial runs were made in order to note the effect of varying several conditions such as the solvent used for the reaction, the optimum length of reaction time, the optimum concentration of hydrogen peroxide and the solvent most suitable for washing the product. One series of experiments in which the reactants were permitted to stand for time intervals up to 30 days indicated that oxidation was virtually complete in 48 hours and, in fact, yields began to decrease after 10 days standing. It is worthy of mention that the only instance in which there was the slightest evidence for the formation of a substance, such as Gazdar and Smiles reported as melting at 79–80° C., occurred following a 30-day reaction time between thiodiacetic acid and 30% hydrogen peroxide. A small amount of a white solid was obtained following the usual in vacuo evaporation. It was insoluble in water but soluble in acetone and, upon recrystallization from that solvent, melted at 79–80° C. It was extremely unstable above its melting point, exploding with considerable violence. A qualitative examination indicated the absence of sulfur and of acid properties. This compound was not identified though its properties were indicative of a labile organic peroxide.

As a result of these experimental data, we recommend the following procedure for the preparation of thionyldiacetic acid. Dissolve 20 grams of thiodiacetic acid in 60 ml. of warm water in a 200 ml. erlenmeyer flask. Cool in an ice-water bath and add slowly 25 ml. of 30% hydrogen peroxide. After the addition is complete, stopper the flask loosely and allow the solution to stand in the cold bath for one hour with occasional agitation by hand and then for 48 hours at room temperature in the dark. Following this period of time pour the solution into an evaporation dish and place in a vacuum desiccator over sulfuric acid. Evacuate and permit evaporation to proceed to dryness. The sulfuric acid may become dark brown but this does not affect the product. Approximately 30 hours is required for this step. The solid residue is washed with small portions of dry ethyl ether, then air-dried. The amount of product should range from 15 to 16 grams representing a 70% yield. The product is white, melts at 119° C. (corr.) with decomposition and gives no test for chloride or sulfate ion.

While the foregoing experiments were in progress, a study of the oxidizing action of nitric acid on thiodiacetic acid was begun. Beckman (5) had reported the preparation of diisoamyl sulfoxide from the sulfide, using fuming nitric acid and Gazdar and Smiles (1) repeated this preparation and found the product to be identical with that obtained from a hydrogen peroxide oxidation. In this investigation, portions of thiodiacetic acid were treated with nitric acid in varying concentration. In trial 1, using fuming nitric acid a vigorous reaction occurred with considerable evolution of heat even when the reaction flask was immersed in an ice-water bath. After the reaction subsided, the reactants were allowed to stand for 48 hours at room temperature. This was followed by in vacuo evaporation to dryness. The residue so obtained was white and quite water-soluble. Both its equivalent weight and its melting point (177–181° C.) suggested that sulfonyldiacetic acid (m.p. 182° C.) was the main product. However, the yield was low and

it is unlikely that any but traces of thionyldiacetic acid could, if formed, withstand the high reaction temperature noted in the early stages of the experiment. Virtually identical results were obtained in trial 2, using concentrated nitric acid and similar reaction conditions, though the yield of sulfonyldiacetic acid was slightly higher. A third trial, with 8N acid, evolved much less heat and was easily controlled. Again the yield was increased but only the sulfone, contaminated with the original thio acid in some quantity, appeared to form. In trials 4 and 5, using 4N and 1N nitric acid respectively, thiodiacetic acid was recovered unchanged. The problem of utilizing sufficiently concentrated acid to promote oxidation of sulfide to sulfoxide without concurrent heat production sufficient to destroy any thionyldiacetic acid which might form, and without concurrent production of considerable amounts of sulfone, was not resolved.

Potassium permanganate has been used in numerous instances to oxidize sulfides to sulfoxides and sulfones. Sulfonyldiacetic acid has been prepared from the thio acid by several investigators, the most recent modification having been reported by Alden and Houston (6) in 1932. Attempts on our part, however, to use permanganate for the production of the intermediate thionyl acid have been unsuccessful.

In some instances the halogens have been used to convert sulfides to higher oxidation products. Earlier mention has been made of Larsson's report (3) that he had made thionyldiacetic acid (m.p. 109° C.) by the action of bromine water on the thio acid. Jonsson (2) records that thionyldiacetic acid and bromine react to produce tetrabromodimethyl sulfoxide (m.p. 52–53° C.) and tetrabromodimethyl sulfone (m. p. 161° C.). Oddy and Dietz (7) have found that when thiodiacetic acid in dilute water solution is treated with bromine an insoluble white solid slowly precipitates out. After recrystallization, it melts at 160–161° C. and analysis indicates that it is tetrabromodimethyl sulfone. This is a confirmation of Jonsson's report. They have found, further, that if thiodiacetic acid is allowed to react with bromine in absolute methyl alcohol solution a product can be isolated which melts at 113.5–115.5° C. and which, according to their analytical data, is tetrabromodimethyl sulfide. In view of these results and of the confirmation given Jonsson's preparation of thionyldiacetic acid by the experimental data in this paper, it is doubtful if the product described by Larsson was thionyldiacetic acid at all. The instability of both thio and thionyl acids in the presence of bromine leads us to believe that his preparation might have been a mixture of these tetrabromo derivatives described above. No experimental work on the oxidizing action of the halogens on thiodiacetic acid was undertaken in this investigation.

PHYSICAL AND CHEMICAL PROPERTIES

Thionyldiacetic acid is a white solid, very soluble in water, ethyl alcohol, and dioxane. It is moderately soluble in acetone and practically insoluble in ethyl ether, petroleum ether and carbon tetrachloride. When pure it melts sharply at 119° C. (corr. with decomposition.

X-ray diffraction patterns of powder samples of both thiodiacetic and thionyldiacetic acids were made and the relative intensities of the lines $\left(\frac{I}{I_o}\right)$ and the interplanar distances (dÅ) were computed. These data are presented in Table I. The line intensities were determined by visual comparison with a photographic grey scale.

The most marked chemical property of this acid is its instability. Upon standing at room temperature it slowly changes to a light yellow color. A 10-gram sample which was set aside for 60 days was found to be almost totally decomposed at the end of that time. Five-gram samples were heated at various temperatures

for 2 hours and, after heating, equivalent weight determinations were made. The results are given in Table II.

In water solution at temperatures above 50° C., the thionyl acid is relatively unstable as it is in cold mineral acid solutions. In hot acid solutions the breakdown is very rapid. Decomposition also occurs under diminished pressure. When placed in vacuo over sulfuric acid, at room temperature, the product yellows rapidly and the sulfuric acid becomes light brown in color.

TABLE I

X-RAY DIFFRACTION PATTERN MEASUREMENTS OF THIODIACETIC ACID AND THIONYLDIACETIC ACID

THIODIACETIC ACID		THIONYLDIACETIC ACID	
$\frac{I}{I_o}$	dÅ	$\frac{I}{I_o}$	dÅ
0.1	4.410	0.2	9.117
1.0	3.958	0.2	4.641
0.15	3.670	1.0	4.069
0.9	3.334	0.15	3.948
0.4	2.938	0.5	3.780
0.5	2.763	0.15	3.528
0.4	2.653	0.2	2.908
0.8	2.437	0.3	2.728
0.1	2.312	0.2	2.568
0.3	2.204	0.25	2.363
0.25	2.018	0.25	2.281
0.55	1.665	0.15	2.169
0.55	1.562	0.15	1.812

TABLE II

EFFECT OF ELEVATED TEMPERATURES UPON THE STABILITY OF THIONYLDIACETIC ACID

TEMPERATURE	TIME OF HEATING	EQUIVALENT WEIGHT (Theor. Value, 83.1)	COLOR OF ACID AFTER HEATING
40° C.	2 hrs.	83.5	White
60° C.	2 hrs.	83.4	Light Yellow
80° C.	2 hrs.	83.0	Light Yellow
100° C.	2 hrs.	82.1	Yellow
120° C.	2 hrs.	78.3	Dark Brown Gummy Mass on Cooling

DERIVATIVES

(*a*) *Salts.*

A rather comprehensive investigation of the insoluble salts of thionyldiacetic acid was made. Aqueous solution of the acid was added to solutions of some eighteen common metallic ions. Heavy insoluble precipitates were obtained with Ag^+, Pb^{++}, Hg^{++}, and Ba^{++}. A small amount of white precipitate formed with Sr^{++} and a small amount of a dark brown precipitate was obtained with Cu^{++}. In general, these insoluble salts were found to be much more stable than the free acid.

The white barium salt is sparingly soluble in hot water but rapidly dissolves, with decomposition, in hot hydrochloric acid. It crystallizes from water with two molecules of water of hydration.

The silver salt is difficultly soluble in hot water but very soluble in hot nitric acid. Quantitative analysis of the air-dried salt indicates no water of hydration. The salt is bright yellow in color when freshly precipitated but slowly darkens upon exposure to air and light.

Lead acetate solution precipitates a white salt insoluble in both hot and cold water but soluble in hot hydrochloric and nitric acids. A quantitative analysis yielded 55.7% lead (calc. 55.8% Pb.).

A white insoluble mercuric salt is formed with mercuric nitrate solution. It is insoluble in hot and cold water but dissolves in hot hydrochloric acid. Analysis yields 55.1% mercury (calc. 55.0% Hg.).

The precipitates formed with strontium and copper ions were not further investigated.

(*b*) *Esters.*

Attempts on our part to prepare esters by direct esterification of thionyldiacetic acid with alcohol were unsuccessful. Jonsson reported that he had made the ethyl ester of the thionyl acid by oxidizing diethyl thiodiacetate with 30% hydrogen peroxide but he gave no data concerning his product. We used this method of preparing the methyl and ethyl esters with some success.

Ten grams of diethyl thiodiacetate was dissolved in 10 ml. of glacial acetic acid and 9 ml. of 30% hydrogen peroxide was added. The solution was allowed to stand for 48 hours then evaporated in vacuo over sulfuric acid for another 48-hour period. The residual liquid was dissolved in ethyl ether and partially reprecipitated with petroleum ether. After washing with water, the liquid was again dried in vacuo for 12 hours. The product had a foul odor and undoubtedly was somewhat contaminated but it could not be further purified without decomposition occurring. A quantitative analysis produced 14.3% sulfur and the product was assumed to be diethyl thionyldiacetate (calc. 14.5% S). The following physical characteristics were determined: boiling point, 160° C. (22 mm.) with decomposition; density, d_{25}^{25} 1.112; refractive index, n_D^{25} 1.1667.

Dimethyl thionyldiacetate was prepared in a similar manner and the following physical characteristics determined: boiling point, 105–107° C. (22 mm.) with decomposition; density, d_{25}^{25} 1.331; refractive index, n_D^{25} 1.4805.

SUMMARY

1. A study has been made of methods for the oxidation of thiodiacetic acid to thionyldiacetic acid and a modified procedure for the preparation of the latter has been recommended.

2. A number of physical and chemical properties of thionyldiacetic acid have been noted.

3. Several salts and two esters of thionyldiacetic acid have been described.

Acknowledgment is gratefully made for the assistance given us by Mr. Bernard Steierman in the x-ray diffraction studies described in this paper.

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SOME ASPECTS OF THE DISTRIBUTION OF LARVAL PARASITES OF THE ORIENTAL FRUIT MOTH IN OHIO

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The Ohio Agricultural Experiment Station has carried on investigations with the oriental fruit moth, *Grapholitha molesta* (Busck), since 1925. During this time collections of fruit moth larvae have been made at frequent intervals each year to determine the extent of larval parasitism. The purpose of this paper is to present an interpretation of the data collected over the sixteen-year period from 1932 to 1947.

Neiswander (1936) last published a list of parasites reared from the larvae of the fruit moth in Ohio. The list below includes the 1936 list plus species collected since that time. Only hymenopterous species are included; some of these are possible secondary parasites.

Apanteles aristoteliae Vier.
A. clavatus (Prov.)
A. epiontiae Vier.
Ascogaster quadridentatus Wesm.
Atrometus clavipes (Davis)
Bassus cinctus (Cress.)
B. diversus Mues.
Calliephialtes grapholithae (Cress.)
Campoplex tortricidus Cush.
C. validus Cress.
Coccygomimus aequalis (Prov.)
Cremastus carpocapsae Cush.
C. epagoges Cush.
C. forbesi Weed
C. minor Cush.
C. tortricidis Cush.
Dibrachys boucheanus (Ratz)
D. cavus (Walk.)
Eubadizon pleuralis Cress.
Euderus subopaca (Gahan)
Eupelmus amicus Gir.
Gambrus ultimus (Cress.)
Gelis tenellus (Say)
Glypta rufiscutellaris Cress.
G. vulgaris Cress.[3]
Goniozus columbianus Ash.
Hemiteles mellicornis Ash.
Horogenes molestae (Uchida)
H. obliteratus (Cress.)
Itoplectis conquisitor (Say)
Macrocentrus ancylivorus Rowh.
M. delicatus Cress.
M. instabilis Mues.
M. pallisteri DeGant
Mastrus pilifrons (Prov.)
Meterorus trachynotus Vier.
Microbracon politiventris (Cush.)
Microgaster ecdytolophae Mues.
Perilampus fulvicornis Ash.
Phaeogenes walshiae walshiae Ash.
Pristomerus ocellatus Cush.
Psychophagus omnivorus (Walk.)
Scambus hispae (Harris)
S. pterophori (Ash.)[3]
Spilochalcis torvina (Cress.)
Trichomma reticulatum Davis
Trichogramma minuta Riley

[1]The author is indebted to the many workers of the Ohio Agricultural Experiment Station who contributed to the collection of the data. Particular acknowledgment should be made to R. B. Neiswander and R. W. Rings of the local station as well as to N. D. Blackburn, now at Pennsylvania State College, for making the data available to the author.

[2]In co-operation with the Division of Fruit Insect Investigations, Bureau of Entomology and Plant Quarantine.

[3]*Glypta vulgaris* (Townes 1944) and *Scambus pterophori* (Balduf 1929) have not been reared from oriental fruit moth larvae in Ohio but do occur in Ohio and are parasites of the pest elsewhere.

Of this list, seven are of major importance. Their percentage occurrence is listed below.

Macrocentrus ancylivorus	60.0%	of parasites
M. delicatus	19.3%	" "
Glypta rufiscutellaris	7.5%	" "
Cremastus minor	5.8%	" "
Pristomerus ocellatus	2.1%	" "
Horogenes obliteratus	1.4%	" "
Ascogaster quadridentatus	0.3%	" "
Others	3.6%	" "

These figures are computed from totals of 81,573 insects reared from collections made in 17 counties and 154 orchards; 39,331 of these insects (48.2%) were parasites.

The percent of parasitism through the entire state is of interest; however, the sampling did not take place in such a way that equal numbers were collected from each portion of the state. It will be noted that parasites occurred in different

TABLE I

PERCENT PARASITIZATION OF ORIENTAL FRUIT MOTH LARVAE BY ALL PARASITES BY SECTIONS—1932–1947

YEAR	NORTH	CENTRAL	SOUTH	AVERAGE
1932	47.3	27.6	20.6	31.8
1933	44.8	37.4	67.6	49.9
1934	46.0	43.6	22.9	37.5
1935	80.2	46.7	47.4	58.1
1936	66.3	37.0	30.5	44.6
1937	48.1	44.4	20.7	37.9
1938	73.1	55.4	46.8	58.4
1939	62.6	38.7	42.7	48.0
1940	50.4	42.9	18.3	37.2
1941	52.2	31.3	35.3	39.6
1942	40.4	67.5	32.3	46.7
1943	38.7	54.3	29.7*	40.9*
1944	47.3	44.8	27.0*	39.7*
1945	47.4	31.1	24.4*	34.3*
1946	58.9	37.7	21.7*	39.4*
1947	44.8	37.2	19.1	33.9
Mean.....	53.0	42.4	31.7	42.4

*These are estimates since no data are available from southern orchards during these years. To obtain these estimated values a straight line has been drawn between the 1942 and 1947 percents of parasitization and indicated values on that line used.

ratios in different sections. For these reasons the calculation of percentages of parasitization from the total number of insects collected does not reveal the true picture. Accordingly, for these investigations, the state has been divided into three portions and the average percent of parasitization of these three sections has been computed for each year. The results are shown in Table 1.

On a state wide basis commercial control of the oriental fruit moth by means of parasites has not been achieved. In isolated areas and on occasional years, control has been satisfactory but the parasite population over the state as a whole remained too low to give good results in spite of large releases of adult parasites.

No trends in percent of parasitization can be noted. Total parasitization has not increased but has remained at a fairly constant level. It will be shown that *M. ancylivorus* has increased in numbers and therefore has done so at the expense

of other parasites instead of contributing to higher levels of parasitization of the host pest.

Since the two species of *Macrocentrus* are the most important parasites in the state and account for the majority of the parasitized fruit moth larvae, their relative proportions have been computed. Counties in which the ratio of *M. ancylivorus* to *M. delicatus* was high include Sandusky, Summit, Lorain, Ottawa, and Cuyahoga; these are in the northern portion of the state. In the central region a medium ratio was found; counties studied in this region were Knox,

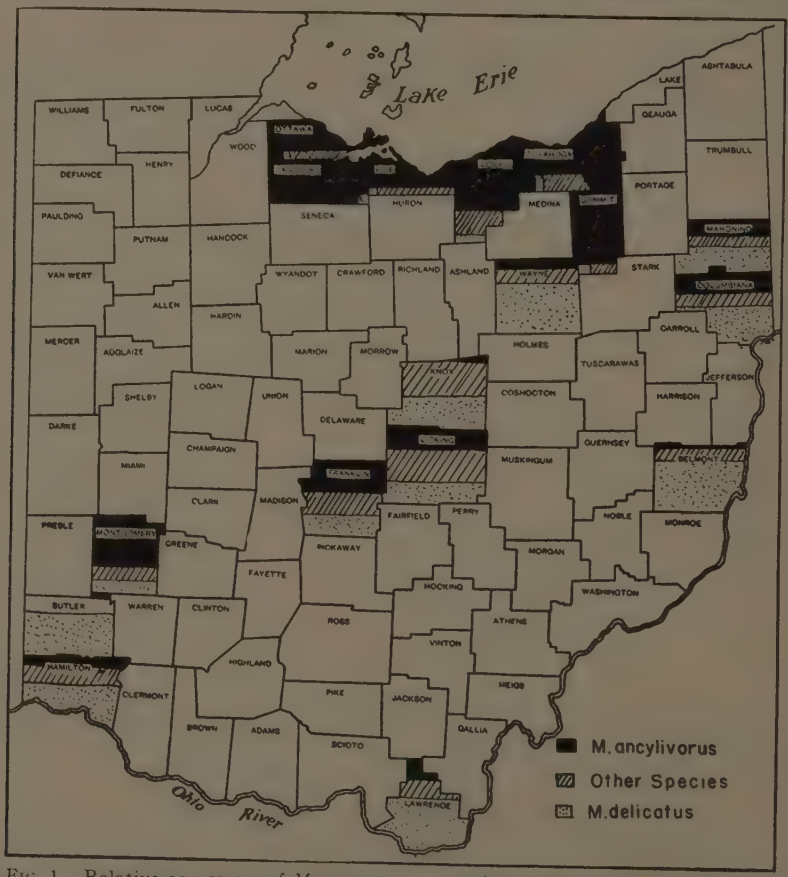

FIG. 1. Relative occurrence of *Macrocentrus* spp. and other parasites of the oriental fruit moth in Ohio. (Percents of county area in black, stippled, and cross-barred, represent the percents of the respective species collected from that county.)

Mahoning, Columbiana, Franklin, Wayne, and Licking. Belmont, Hamilton, Butler, and Lawrence comprise the southern counties in which a low ratio was found. That is, the ratio between the two species was high in the north and decreased to the south. Total parasitization of oriental fruit moth larvae showed the same type distribution.

Of the counties studied one important exception is made. Montgomery County which is geographically located in the southern section is omitted. Here

the occurrence of *M. ancylivorus* has been predominant, probably because of the presence of extensive plantings of strawberries that supported a large strawberry leaf-roller (*Ancylis comptana fragariae* (W. & R.)) population and consequently a high *M. ancylivorus* population.

The nature of the distribution of these two species in the state is shown on the map in Figure 1. Solid black portions show the percent of *M. ancylivorus*; stippled areas represent the percent of *M. delicatus*; cross-barred areas show the percent of other parasites. Counties without markings are not represented in this report. Inspection of the map will show that in counties in the southern section the predominant species was *M. delicatus*, while in northern counties it was *M. ancylivorus*. In the central section counties the parasitism was more or less evenly divided between the two species.

TABLE II

PROPORTIONS OF *M. ancylivorus* TO *M. delicatus* BY GEOGRAPHCIAL SECTIONS FOR THE YEARS 1932–1947

	NORTH		CENTRAL		SOUTH	
	M. anc.	M. del.	M. anc.	M. del.	M. anc.	M. del.
1932	96	4	31	69	1	99
1933	82	18	4	96	1	99
1934	89*	11	16	84	1	99
1935	99	1	37	63	1	99
1936	99	1	3	97	8	92
1937	99	1	9	91	0	100
1938	99*	1	22*	78	1	99
1939	96*	4	10*	90	1*	99
1940	97*	3	35*	65	33*	67
1941	99*	1	55*	45	43*	57
1942	95*	5	27*	73	64*	36
1943	94*	6	32*	68		
1944	94*	6	57*	43	no record	
1945	96*	4	67*	33		
1946	99*	1	92*	8		
1947	93*	7	66*	44	56	44

*Indicates that releases of more than 400 adult *M. ancylivorus* were made in the area for the year.

The author attempted several correlations of the relative abundance of the two *Macrocentrus* species with various climatic phenomena. None of the factors investigated presented a pattern that would account for the distribution of the species. Inadequacy of weather data in studies of this type makes any conclusions impossible.

The relative proportion of *M. ancylivorus* to *M. delicatus* is shown in Table II.

The conclusions from the table are obvious. In the northern section, *M. ancylivorus* clearly predominated. In the central section, *M. delicatus* predominated for the first nine years and *M. ancylivorus* has shown the lead in five of the past seven and four of the last four years. Prior to 1942 *M. delicatus* was dominant in the southern regions but *M. ancylivorus* has shown an increase since 1940 and in the last two years of record (1942 and 1947) has made up more than fifty percent of the total of the two species. It is well known that in cases of multiple parasitism *M. delicatus* usually suffers in competition with *M. ancylivorus*.

In northern Ohio, Neiswander (1936) has shown that releases of adult *M. ancylivorus* in Ottawa County established the species and contributed to a high

parasitization of fruit moth populations. The significance of the increase of *M. ancylivorus* in southern Ohio in the year 1940 has not been determined. It appears, however, that parasite liberations were a contributing factor in the accumulation and perpetuation of the species in the south although there is no statistical correlation between the numbers of *M. ancylivorus* released and the numbers of this parasite recovered.

It is probable that *M. ancylivorus* was not indigenous to Ohio. If not, there is the possibility that after 15 years of the presence of the oriental fruit moth the species was yet in the process of becoming established and the release of adults was necessary to achieve success. After establishment it could build up its numbers without additional assistance. The fact that from 1942 to 1947 in the southern section there were no releases, yet the species continued at a high level, lends weight to this argument.

The conclusion that *M. ancylivorus* is increasing in relation to *M. delicatus* may be made from the above data. It now becomes desirable to investigate the relation of *M. ancylivorus* to the oriental fruit moth population. Table 3 shows this relationship.

TABLE III

PERCENT OF FRUIT MOTH LARVAE PARASITIZED BY *Macrocentrus ancylivorus*

	NORTH	CENTRAL	SOUTH
1932	18.0	1.6	1.0
1933	17.4	1.3	0.0
1934	26.3	6.7	1.0
1935	73.9	13.3	0.0
1936	58.7	1.0	2.2
1937	44.1	3.0	0.0
1938	53.4	8.4	1.0
1939	46.9	3.3	1.0
1940	39.0	14.9	5.7
1941	33.0	15.9	14.0
1942	24.7	15.7	14.4
1943	30.1	16.1	
1944	34.8	24.8	no
1945	41.3	16.7	record
1946	50.5	30.4	
1947	40.4	23.6	10.3
Average	39.5	12.3	4.2
Slope*	+ .32	+ 1.66	+ 1.58

*Indicates the slope of a straight line fitted through the points and indicates the rise in percent per year.

The slopes of the three lines cannot be demonstrated to be statistically significant for the entire group of years. In the south and central sections, however, since 1940 the rise has been sharp, indicating that *M. ancylivorus* is parasitizing a larger percentage of larvae than in the past.

Since *M. ancylivorus* is parasitizing a larger number of larvae it might be concluded that it is bringing about better control of the oriental fruit moth. However, in view of the fact that the percent of parasitism is not increasing in any section of the state and *M. ancylivorus* is competing with *M. delicatus*, it must be maintained that *M. ancylivorus* is increasing at the expense of other parasites and not at the expense of the fruit moth. The desirability of this condition is open to question.

SUMMARY

Macrocentrus ancylivorous, *M. delicatus*, *Glypta rufiscutellaris*, and *Cremastus minor* are the most important parasites of the oriental fruit moth in Ohio. The first two species accounted for 60.0 and 19.3 percent, respectively, of the larval parasitization of the fruit moth over a 16 year period. (1932–1947). The average percent of fruit moth larvae parasitized by all parasites during this period was 42.4%. Percent of parasitization showed no upward trend over the period.

The state is divided roughly into three geographical sections on the basis of relative occurrence of *M. ancylivorus* and *M. delicatus*. The former is high in the northern section with the proportion decreasing from the north to the south. The percent of total parasitism exhibits the same relationship; high parasitization occurs in the north and decreases from north to south. The proportion of *M. ancylivorus* to other parasites is very high in the northern section and has been on the increase in the central and southern sections since 1940. Releases of adult *M. ancylivorus* are probably partially responsible for this increase. The percent of larvae parasitized by *M. ancylivorus* is also increasing slowly in the northern area; more rapidly in the central and southern sections. *M. ancylivorus* is achieving its increase at the expense of other parasites rather than contributing to the increased destruction of the host insect.

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Neiswander, R. B. 1936. Oriental Fruit Moth Investigations in Ohio II. Ohio Agr. Exp. Sta. Bull. 569: 1–30.

Townes, H. K. 1944. Catalogue and Reclassification of the Nearctic Ichneumonidae. Memoirs of Amer. Ent. Soc. No. 11. Parts 1 and 2.

WILDLIFE FACTS

The National Wildlife Federation estimates that the yield of commercial fish can be increased by over forty per cent in a few years through the use of conservation practices.

Approximately one hundred and thirty different species of fish are captured commercially in waters adjacent to the United States and Alaska, reports the National Wildlife Federation.

Gigantic lizards, says the National Wildlife Federation, were the motives for many of the legends of winged dragons and griffins; consequently, their modern descendants are the subject of superstition and fear.

The heaviest flying bird in America, says the National Wildlife Federation, is the trumpeter swan with a maximum weight of forty pounds.

Sixty-six species of birds are enemies of the cotton boll weevil, reports the National Wildlife Federation. Among these are the Bobwhite Quail, Red-headed Woodpecker, Bluejay, and the Oriole.

Twenty-four birds help control the chinch bug, reports the National Wildlife Federation, an insect pest that does great damage to wheat. Among these birds are the Meadowlark, the Flicker, and the House Wren.

The National Wildlife Federation requests you not to pick or dig wild flowers unless they are abundant.

To birds must go the credit for being a vital factor in checking the hoards of injurious insects, weed seeds, and small rodents, reports the National Wildlife Federation. Without birds, agriculture would be next to impossible.

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1949

Organized 1891 Incorporated 1892
Affiliated with the American Association for the Advancement of Science

OFFICERS AND COMMITTEES FOR 1949–1950

President
PAUL B. SEARS

Vice-Presidents

A. *Zoology:* W. F. HAHNERT
B. *Plant Science:* J. F. STANFIELD
C. *Geology:* R. J. BERNHAGEN
D. *Medical Sciences:* I. D. PUPPEL
E. *Psychology:* A. G. BILLS
F. *Physics and Astronomy:* M. L. POOL
G. *Geography:* C. M. WILSON
H. *Chemistry:* R. G. BOSSERT
I. *Mathematics:* L. P. CUMMINS
J. *Science Education:* H. C. HULME
K. *Anthropology:* F. L. UTLEY

Secretary
RUSH ELLIOTT

Treasurer
R. M. GEIST

Historian
WILLIAM H. ALEXANDER

COMMITTEES

Executive Committee
Ex-Officio: PAUL B. SEARS, RUSH ELLIOTT, R. M. GEIST
Elective: G. B. BARBOUR, G. W. BLAYDES

Membership

A. *Zoology:* G. D. MORGAN, Chairman
B. *Plant Science:* C. C. ALLISON
C. *Geology:* J. O. FULLER
D. *Medical Science:* C. A. ANGERER
E. *Psychology:* C. O. MATHEWS
F. *Physics and Astronomy:* H. V. KNORR
G. *Geography:* H. F. RAUP
H. *Chemistry:* G. L. ORR
I. *Mathematics:*
J. *Science Education:* HARLEY ELLINGER
K. *Anthropology:* KURT H. WOLFF

Nominating
VICE-PRESIDENTS OF 1948–1949, E. T. BODENBERG, Chairman

Program
VICE-PRESIDENTS OF SECTIONS AND SECRETARY

Library
MISS LILLIAN MICHAELIS, Chairman
Librarian in charge of Academy Exchanges and Publications
R. A. HEFNER.....Term expires 1951
W. M. TIDD.....Term expires 1953

Publications
SECRETARY, Chairman
R. A. HEFNER.....Term expires 1951
W. M. TIDD.....Term expires 1953

Conservation
C. A. DAMBACH, Chairman..Term expires 1950
R. V. BANGHAM.....Term expires 1950
R. W. FRANKS.....Term expires 1950
E. S. THOMAS.....Term expires 1951
P. B. SEARS.....Term expires 1951
FRANK J. WRIGHT.....Term expires 1951
JAMES R. BECK.....Term expires 1952
R. A. HEFNER.....Term expires 1952
E. L. RICE.....Term expires 1952

Necrology
J. E. CARMAN, Chairman...Term expires 1950
CARL VER STEEG.....Term expires 1951
H. H. M. BOWMAN.....Term expires 1952

Resolutions
P. B. SEARS.....Term expires 1950
W. C. BEAVER, Chairman...Term expires 1951
H. R. EGGLESTON.....Term expires 1952

Trustees of Research Fund
E. LUCY BRAUN.....Term expires 1950
HERBERT O. OSBORN.....Term expires 1952
E. N. TRANSEAU, Chairman.Term expires 1951

Academy Representatives

1. On the Joint Administrative Board of the Ohio Journal of Science:
   R. A. Hefner.....Term expires in 1951
   W. M. Tidd.....Term expires in 1953
2. On the Council of the A. A. A. S.: G. W. Blaydes.
3. On the Save-Outdoor-Ohio Council: R. W. Franks.

The Council for 1949–1950

Allison, C. C.	Ellinger, Harley	Knorr, H. V.	Puppel, I. D.
Angerer, C. A.	Elliott, Rush	Mathews, C. O.	Raup, H. F.
Barbour, G. B.	Fuller, C. O.	Michaelis, Lillian	Sears, P. B.
Bernhagen, R. J.	Geist, R. M.	Morgan, G. D.	Stanfield, J. F.
Bills, A. G.	Hahnert, W. F.	Osborn, Herbert	Tidd, W. M.
Blaydes, G. W.	Heffner, R. A.	Orr, G. L.	Utley, F. L.
Bossert, R. G.	Hulme, H. C.	Pool, M. L.	Wilson, C. M.
Cummins, L. P.	Lindsey, A. W.	Popham, R. A.	Wolff, Kurt H.
Dambach, C. A.			

REPORT OF THE FIFTY-EIGHTH ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The Academy met for the second time in this decade on the campus of Denison University on April 21, 22, 23. The Executive and Council meetings were held on April 21 and sectional meetings on April 22, 23. The local committee, under the chairmanship of Dr. A. W. Lindsey, had made excellent arrangements, the attendance was above average and programs were presented by all sections.

The first Annual Science Day for the Junior Academy under the reorganized plan was held on April 22, and this was an extremely successful program. The entire Junior Academy program is growing rapidly. The annual banquet and business meeting was held at the Granville Inn on Friday evening at 6:30. Dr. A. W. Lindsey served as toastmaster. Greetings were extended by Dean C. F. Richards of Denison University, and response was given by Dr. H. H. M. Bowman. The presidential address was given by Dr. George B. Barbour on the title, "Ape or Man? The Recent Discoveries in South Africa."

The annual report of the Secretary contained another milestone in the history of the Academy. Two hundred and twelve persons were elected to membership in the Academy, the largest number in any single year, and the total membership has passed the 1,000 mark for the first time.

The following persons were elected as fellows of the Academy:

James A. Bright	Richard P. Goldthwait	Ralph B. Neiswander
Floyd J. Brinley	Harold C. Hulme	Grover L. Orr
E. R. Bryant	Arne V. Hunninen	Earl E. Sanderson
Harold U. Cope	George A. Kelly	George S. Sperti
William P. Cross	Eleanor Longbrake	Elizabeth K. Weisburger
James W. Cummins	Joseph T. Maddox	Curtis M. Wilson
Harley Ellinger	John H. Melvin	Kurt H. Wolff
Daniel L. Friedberg		

The report of the Nominating Committee was presented by Dr. Ralph A. Dexter, of the Necrology Committee by Dr. J. E. Carman, and of the Resolutions Committee by Dr. W. C. Kraatz.

Respectfully submitted,

Rush Elliott, *Secretary.*

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The Executive Committee met on December 3, 1948, and again on April 21, 1949, and the Council on December 4, 1948, and again on April 21, 1949.

A special committee (R. L. Edwards, chairman, F. H. Krecker, G. W. Blaydes, W. M. Tidd, and James Vaughn) appointed to study the allocation of funds of the Academy presented a report at the winter council meeting. The report was accepted and the committee discharged. Since the report did not cover some of the current problems, another committee (Eugene Van Cleef, chairman, F. H. Krecker and A. W. Lindsey) was appointed to consider methods of increasing the income of the Academy and the allocation of the funds collected. This committee made a very exhaustive report at the April meeting of the Council, and a number of recommendations were made which will require amendments to the constitution. These are to be prepared for consideration by the Council in 1949–1950.

The Executive Committee received the resignation of W. M. Tidd as Treasurer and appointed R. M. Geist to complete the year. He was elected as Treasurer on the recommendation of the Nominating Committee.

The Council approved the election to Honorary Life Membership of E. L. Rice and Frank J. Wright.

The Council approved a number of recommendations presented by F. H. Krecker for the Junior Academy program.

The 1950 annual meeting is to be held on the campus of Capital University on April 27, 28, 29, as a part of the centennial program of the University.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE TREASURER

COLUMBUS, OHIO, April 21, 1949.

To the Ohio Academy of Science:

I submit herewith a financial statement of the condition of the Ohio Academy of Science as of December 31, 1948. The books have been audited and the opinion of the auditor is herewith attached.

Respectfully submitted,

R. M. GEIST, *Treasurer.*

OHIO ACADEMY OF SCIENCE BALANCE SHEET
As at December 31, 1948

ASSETS

CURRENT EXPENSE FUND:		
Cash in Bank		$ 489.62
Bonds owned:		
U. S. War Savings Bond—Series F (Cost)	$ 111.00	
U. S. War Savings Bond—Series G (Cost)	1,900.00	
Total Bonds Owned		2,011.00
Total Assets—Current Expense Fund		$2,500.62
RESEARCH FUND:		
Cash in Bank	$ 239.11	
Bonds Owned:		
Fort Hayes Hotel, Columbus, Ohio (Cost)	$1,300.00	
U. S. War Savings Bond—Series G (Cost)	300.00	
Total Bonds Owned	1,600.00	
Banc-Ohio Securities Stock	437.50	
Total Assets—Research Fund		2,276.61
Total Assets		$4,777.23

LIABILITIES AND NET WORTH

CURRENT EXPENSE:		
Deferred Credits:		
1949 Dues collected in 1948		$ 107.50
NET WORTH:		
Ohio Academy of Science:		
Current Expense Fund	$2,393.12	
Research Fund	2,276.61	
Total Net Worth		4,669.73
Total Liabilities and Net Worth		$4,777.23

Ohio Academy of Science Statement of Income and Expense
For the Year Ended December 31, 1948

Current Expense fund

Income:		
Dues from Members		$1,982.50
Grants for Research		156.25
Sale of Publications		10.00
Interest on Bonds		47.50
Total Income		$2,196.25
Expenses:		
Operating—		
Subscriptions—Ohio Journal of Science	$1,147.50	
Printing Proceedings 1948	174.25	
Printing—other	276.40	
Honorarium—secretary	150.00	
Postage and Office Expense	226.61	
Bank Charges	15.59	
Clerical and Auditing	50.00	
Total Operating	$2,040.35	
Science Education Section—		
Postage and Office Expense	$20.16	
Printing	30.00	
Total Science Education Section	50.16	
Non-Operating Expense—		
A. A. A. S. Research—Special Grant	156.25	
Total Expenses		2,246.76
Excess of Expenses Over Income		$ 50.51

Research Fund

Income:		
Gifts for Research		$72.00
Interest		18.75
Total Income		$90.75
Expenses:		
Grants for Research	$97.97	
Bank Charges	.98	
Total Expenses		98.95
Excess of Expenses Over Income		$ 8.20

AUDITOR'S CERTIFICATE

Columbus, Ohio, April 1, 1949.

To the Ohio Academy of Science, Columbus, Ohio.

Gentlemen:

In accordance with your instructions, I have examined the accounts and records of the Ohio Academy of Science for the year ended December 31, 1948.

A detailed audit was made of all transactions handled by the treasurer. Cash in the bank was verified by bank certification. Securities in safety deposit box were verified by personal examination. My examination was made in accordance with generally accepted auditing standards.

In my opinion, the accompanying balance sheet and the statement of income and expense (cash basis) fairly represents the financial position at December 31, 1948, and the results of operations on a cash basis for the year ending December 31, 1948. These statements are in conformity with generally accepted accounting principles.

Respectfully yours,
D. M. Shonting,
Certified Public Accountant.

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

Your trustees present herewith a report of the grants made from the A. A. A. S. and the Academy for the year 1948.

As there had been no requests except a small one granted to Mr. Wood, the Chairman addressed a letter to other Trustees and to a few members who might know of worthy projects, stating that it was desirable at least to have applications to cover the allotment from the A. A. A. S. As a result he received some applications which, when approved by the Trustees, were assigned as follows:

To Mr. Ralph H. Bond for study of microscopic fossils, conodonts in shale formations, $156.25 from the A. A. A. S. grant.

To Mr. Joe R. Stratton of The University of Toledo for securing and maintaining guinea pigs for experimental work, $48.00.

To Dr. Ralph W. Dexter of Kent State University for studies on distribution of the Fairy Shrimp, $25.00.

The grant to Mr. Richard D. Wood for plates to illustrate an article in the *Ohio Journal of Science* was $26.80.

We may repeat the notice that we may expect some $150.00 or more from the A. A. A. S. for 1949 and that our Academy fund now $264.70, will permit other grants for desirable studies.

Respectfully submitted,

E. Lucy Braun,
Edgar N. Transeau,
Herbert Osborn, *Chairman.*

REPORT OF THE LIBRARY COMMITTEE

With a great amount of help from the Treasurer of the Academy, and the co-operation of each member contacted, the mailing list of the *Ohio Journal of Science* has been coded to show whether the recipient is a member, a subscriber, or on exchange.

There are now 356 exchanges, slightly fewer than when last reported.

In 1948 the sale of special papers amounted to ten dollars, which amount has been given the Treasurer of the Academy.

Respectfully submitted,

Lillian Michaelis.

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

The annual meeting of the Joint Administrative Board of the *Ohio Journal of Science* was held in Columbus, Ohio, April 9, 1949. The meeting was called to order by the Board Chairman, Dr. Spieker. Present were Drs. Meyer and Spieker representing the Ohio State University; Dr. Hefner representing the Academy; and Drs. Blaydes and Miller representing the *Ohio Journal of Science.* Dr. Anderson, an Academy representative, was unable to be in attendance. Dr. Spieker was nominated by Dr. Meyer to continue as Chairman. The motion was seconded by Dr. Hefner. Dr. Miller continued to serve as secretary of the Board.

The minutes of the preceding meeting were read and approved. The Chairman called for the report of the Business Manager. Dr. Miller's report was largely in the form of a financial statement for Volume 48 of the *Journal.* A copy of the financial statement is attached to this report. Dr. Hefner moved the acceptance of the financial statements as read; seconded by Dr. Meyer. The motion carried.

In commenting on the financial picture Dr. Miller called attention to the net loss in assets for the fiscal year of $294.65, the operating balance on hand having been reduced from $533.52 at the beginning of the fiscal year to $238.87 at the close of business February 23, 1949. This difference is not due entirely to increased production costs. Volume 47 of the *Journal* cost $3038.53 and Volume 48 cost $3088.94, an increase of only $50.41. The real difference is between the $617.66 collected in 1947 as authors' payment of publication costs as compared with $123.50 collected in 1948.

Dr. Miller also reported that during the year, in co-operation with the treasurer and librarian of the Academy, suitable keys were added to the filing and mailing stencils, thus facilitating easy recognization of members, subscribers and exchanges.

Dr. Hefner moved the acceptance of the Business Managers report; seconded by Dr. Meyer, and passed.

The Chairman then called for the Editor's report. Dr. Blaydes presented a review of papers in Volume 48. Briefly, Volume 48 consisted of 252 pages, consisting of 39 papers from 11 science areas. Four book reviews were also printed. There are 17 manuscripts on hand. Following the Editor's formal report the Board discussed the procedure in reviewing manuscripts. The Board concurred in the accepted procedure of submitting each manuscript to the Review Board. The report of the Editor was accepted on a motion by Dr. Meyer; seconded by Dr. Hefner.

The Chairman called for an election of Editor and Business Manager for Volume 49. Dr. Hefner moved the appointment of Dr. Blaydes as Editor for Volume 49. The motion was

seconded by Dr. Meyer. Dr. Blaydes was unanimously elected as Editor of Volume 49. Dr. Miller then presented his resignation as Business Manager of the *Journal* and Secretary of the Joint Administrative Board. Dr. Meyer moved the acceptance of Dr. Miller's resignation, seconded by Dr. Hefner, and passed by the Board.

Dr. Spieker then presented to the Board the task of nominating and selecting Dr. Miller's successor. In the discussion which followed mention of an assistant editor was introduced as being pertinent, Dr. Blaydes having indicated his desire to be relieved of the editorship in the near future.

Dr. Hefner presented the following motions, which were seconded by Dr. Spieker: first, Dr. Meyer and Dr. Miller be appointed with authority to interview and select from the list recommended by the Board, a new business manager; second, Dr. Spieker and Dr. Blaydes be appointed with authority to interview and select, from the list recommended by the Board, an assistant editor. Both motions were individually acted upon and passed by the Board.

Dr. Hefner moved, seconded by Dr. Meyer, that the Auditing Committee, composed of Drs. Spieker and Meyer, be retained and authorized to proceed with the auditing of the *Journal* business. Passed.

Dr. Spieker reported to the Board that Dr. Blaydes and himself called upon President Bevis of Ohio State University and requested that the University's stipend be increased from $1000.00 to $1500.00 per year. Dr. Spieker is awaiting the reply to this request.

Dr. Blaydes, as editor of the *Journal*, once again asked that the section Vice-Presidents of the Academy be on the alert during their programs for papers suitable for *Journal* publication. The Editor requests that such titles and authors be referred directly to him by section Vice-Presidents.

There being no further business the Board was adjourned on a motion by Dr. Meyer, seconded by Dr. Hefner.

Respectfully submitted,

JOHN A. MILLER,
Secretary of the Board.

THE OHIO JOURNAL OF SCIENCE

Fiscal Year 1948

RECEIPTS

Balance from 1947	$ 533.52
University Allowance	1,000.00
Ohio Academy of Science—pro rate of dues	1,140.00
Ohio Academy of Science—proceedings	174.25
Subscriptions	145.00
Sale of back numbers	16.70
Author's payment for plates	194.84
Payment by authors and institutions of publication costs	123.50
	$3,327.81

EXPENDITURES

Spahr and Glenn, Printing—Vol. 48	$2,594.24
Spahr and Glenn, Manilla Envelopes	63.55
Bucher Engraving Company	242.61
Postmaster	150.11
Bank Charges	1.68
Refund	1.50
Clerical Assistance	32.25
Labor	3.00
	$3,088.94
Balance on hand, Feb. 23, 1949, (Huntington National Bank, Columbus, Ohio)	$ 238.87

REPORT OF THE COMMITTEE ON CONSERVATION

Your Committee on Conservation offers the following report for the consideration and approval of the Ohio Academy of Science:

We note that 74 of Ohio's 88 counties now have organized soil conservation districts.

We note greatly increased attention given by public and private agencies to water conservation as it involves the retention of water where it is needed and also as it involves soil loss and floods.

We note greatly increased attention given by public and private agencies to the problem of water pollution in all its aspects.

We note increased attention to the matter of the conservation and restoration of our forests, to the development of ground cover for eroded lands, for the development of better land use programs in agriculture.

We note the development of programs for the conservation and restoration of wild life and these programs also have engaged the attention of private as well as state agencies.

We submit the thought that the research and the techniques resulting from such study which will result in an intelligent, comprehensive and correlated program of conservation lie entirely within the field of applied sciences and thus fall within the province of The Ohio Academy of Science.

It has been the practice in the past for this committee to recommend that the members of the Academy, as individuals, should not only make available to all agencies engaged in conservation their knowledge but to take an active part in conservation activities. However, the conservation of the natural resources of our state has now become a problem of such outstanding importance to the economy of the commonwealth that there is a feeling in the minds of your committee that the time has arrived for the Ohio Academy of Science to take an active and well-planned part as an organization in Ohio's program of conservation.

Therefore, your committee suggests and recommends that the President of the Academy shall create a Planning Board to formulate a suggested plan for the Academy's participation in the conservation program. We suggest that this planning group should include, in addition to the members of the conservation committee, such members of the Academy as can be of service in formulating the plan, these to be chosen by the President of the Academy. We suggest that the President set a date for the meeting or meetings of said Planning Board. We also suggest that it would be desirable for the Planning Board to have at least a preliminary report to present to the winter meeting of the Council of the Academy.

We suggest that the time and manner in which the final report of the Planning Board is to be presented to the Academy for discussion and approval shall be left to the discretion of the President.

Respectfully submitted,

C. E. Taft, E. S. Thomas,
R. V. Bangham, Paul B. Sears,
R. W. Franks, F. J. Wright,
C. A. Dambach, A. W. Harper, *Chairman.*

REPORT OF THE COMMITTEE ON NECROLOGY

The Committee on Necrology reports with deep regret the death of six members of the Academy since the last annual meeting. The following memorial statements were written by colleagues of the deceased members as indicated by the name following each statement.

Respectfully submitted, H. R. Eggleston,
Karl Ver Steeg,
J. Ernest Carman, *Chairman.*

Rolland Craten Allen

The State of Ohio, the nation, the mining industry, and the scientific world lost an outstanding and distinguished citizen by the death of Rolland Craten Allen on July 18, 1949. Mr. Allen was born at Richmond, Indiana, in 1881, spent most of his early manhood in Wisconsin, about ten years of his middle manhood in Michigan, and the rest of his life as a citizen of Ohio. He received the Bachelor's degree from the University of Wisconsin in 1905, the Master's degree in 1908, and was awarded the honorary degree Doctor of Engineering by Rensalaer Polytechnic Institute in 1939.

Dr. Allen's service was both varied and important. After receiving the Bachelor's degree he taught high school at Plymouth, Wisconsin, and conducted geological exploration in Ontario, Canada. After receiving the Master's degree he was instructor in geology at the University of Michigan for one year (1908–1909) and then became State Geologist of Michigan, where he served for about ten years. From 1919 to 1947 he was connected with the Lake Superior Iron Ore Association, Cleveland, Ohio, first as vice-president and then as president. In 1921 he became executive in charge of mining operations for Oglebay, Norton and Co., Cleveland, and in 1924 executive vice-president. While serving with that company (1930–31) he went to Russia as an adviser on developing iron ores for the Russian government. He served the United States government during the first world war as a member of the Federal Excess Profits Tax Board, in charge of matters relating to natural resource industries, and again during the second world war with the Advisory Committee for National Defense, handling procurement of strategic minerals for iron and steel production, and with the War Production Board as vice-chairman of minerals and metals.

He was a member of the American Institute of Mining and Metallurgical Engineers (director, vice-president, president); the Society of Economic Geologists (director, vice-president); a fellow of the Geological Society of America; a member of the Mining and Metallurgical Society of America; the American Iron and Steel Institute; the American Academy of Political Science; the Cleveland Engineering Society; the American Association for the Advancement of Science; and the Society of the Sigma Xi. He was trustee of Western Reserve Academy, Hudson, Ohio (his home town); and trustee and president (at the time of his death) of Battelle Memorial Institute, Columbus, Ohio.

Mr. Allen's clear thinking, breadth of vision, good judgment, and understanding of people made him an outstanding personality. Of him it has been said by a close associate that he

"rendered unique service to his profession, to the mining industry and to his country, and created for himself a place in the hearts of all who knew him that remains an inspiration to them and a tribute to him as a splendid citizen."—*Carl A. Lamey.*

Arthur Riggs Altick

Arthur Riggs Altick was born in Dayton, Ohio, June 22, 1891, and died July 21, 1947, from injuries received in an automobile accident. He graduated from the Springfield High School, Class of 1912, and later attended Wittenburg College. Early in his career he served as Secretary of the Springfield Chamber of Commerce, during which time he was active in Boy Scout affairs.

In 1933 Mr. Altick was elected Secretary of the Clark County Historical Society and Curator of its museum, which positions he held until his death. In this capacity he explored prehistoric mounds and village-sites in Clark and adjacent counties. He was an able artist, and his numerous reports of explorations, published in newspapers and magazines, were illustrated by his personal drawings. At the time of his passing he had in preparation a book-length manuscript recording his explorations and illustrating artifacts in the Clark County Museum and elsewhere.

Mr. Altick held memberships in the Ohio Academy of Science and the Society for American Archaeology. He is survived by his widow, Ethel, and two sons, Richard and Arthur.

—*H. C. Shetrone.*

Floyd C. Dockeray

Floyd C. Dockeray, Professor in the Department of Psychology at The Ohio State University, died January 15, at the age of 68. His academic training was received at the University of Michigan with a Bachelor's degree in 1907, a Master's degree in 1909, and a Doctor's degree in 1915. He taught at the University of Kansas from 1910 to 1915 and 1917 to 1920, and then went to Ohio Wesleyan where he was chairman of the Psychology Department until he came to Ohio State in 1929. One of his major contributions at Ohio State was the supervision of the introductory courses in the department. He also contributed to the advanced teaching program and supervised the research work of many graduate students.

His research interests have been primarily in general and comparative psychology but also to some extent in aviation psychology. During the first war he contributed some pioneer work on the selection of airplane pilots and also learned to fly in that connection. For a time he supervised the infant behavior laboratory operated by the Psychology Department and the Medical School. During and subsequent to the last war he was active in aviation psychology problems and directed a number of projects sponsored by the National Research Council. His writings involve numerous research articles and a widely used textbook in beginning psychology. Doctor Dockeray belonged to Phi Beta Kappa, Sigma Xi, American Psychological Association, American Association for the Advancement of Science, Southern Society of Philosophy and Psychology as well as our own Ohio Academy of Science. In the long perspective he will be remembered best by some of his research contributions to theoretical psychology and by the careers of advanced students to whom he gave generously of his time in helping plan their graduate programs.—*Harold E. Burtt.*

William Clarence Ebaugh

William Clarence Ebaugh, Professor of Chemistry at Denison University, 1917–1944, died December 28, 1948, a few days prior to his seventy-second birthday.

He was born and educated in Philadelphia and received from the University of Pennsylvania the degrees of B. S. (1898) and Ph. D. (1901). During his earlier years he served as a chemist in an iron and steel laboratory near Reading, Pennsylvania, and with the American Smelting and Refining Company, Salt Lake City, Utah. He taught physics and chemistry at Kenyon College, Ohio (1901–1902), and from 1903 to 1915 was Professor and Director of the Department of Chemistry at the University of Utah.

From 1917 until the time of his serious illness in October, 1944, he was Professor of Chemistry and Department Head at Denison University, excepting the academic year 1930–31, when he taught as an exchange professor in Robert College, Istanbul, Turkey. After his illness in 1944 he lived in retirement, as Professor Emeritus in Granville.

In addition to his teaching and administrative duties he was active throughout his professional career as an industrial research worker, and as editor of scientific journals. His industrial research dealt primarily with steel analysis, smelter smoke, pollution of the atmosphere by smelter fumes, and gas producers. In Utah he served as associate editor of the *Journal of Industrial and Engineering Chemistry*, and at Denison he was for over twenty years the Secretary of the Denison Scientific Association and Editor of the *Journal of the Scientific Laboratories.*

Dr. Ebaugh was a member of many learned and professional societies, including the Ohio Academy of Science, the American Chemical Society, the American Association for the Advancement of Science, and the American Society for Engineering Education. He was a member of Sigma Xi, and of Beta Theta Pi, social fraternity. He served long and faithfully in the Baptist Church. His avocation was music and he was an excellent organist.

Dr. Ebaugh will be long remembered by his many students, associates and friends as a

vigorous man, staunch and energetic, kindly, sympathetic, generous and reliable as a friend and counsellor. His was a full life, filled with willing services—to family, students, and friends.—*W. A. Everhart.*

Edwin Lincoln Moseley

On June 6, 1948, Bowling Green State University lost one of her pioneer professors, and the Ohio Academy of Science one of its founders and charter members by the death of Dr. Edwin Lincoln Moseley. Of frail physique throughout life, he was nevertheless active almost to the time of his death, having shortly before made a second trip to Mexico.

Born in Union City, Michigan, in March, 1865, Edwin Moseley entered the University of Michigan at the age of sixteen, and received the A. B. and M. A. degrees in 1885. After teaching for two years in the Grand Rapids High School he joined the Beal-Steere Zoological Expedition to the Philippines and returned with the nucleus of what grew to be a very good collection of bird and mammal skins. By nature a prodigious collector of all kinds of scientific and historical materials, he developed a museum in the Sandusky High School, where he subsequently taught science for twenty-five years. In 1914 he was appointed a member of the original faculty of Bowling Green State University, which position he held until his retirement in 1935. Ultimately the Sandusky Museum was merged with the collections at Bowling Green State University. In 1943, he was awarded the degree of Doctor of Humane Letters, and was given the title of Curator of the University Museum.

The versatility of Professor Moseley is shown by the fact that during the early years at Bowling Green he taught geology, chemistry, and physics, as well as biology; and by his authorship of books of such diverse character as "Trees, Stars and Birds," "Our Wild Animals," and "Other Worlds." His journal papers were numerous and included such titles as "Milk Sickness Caused by White Snakeroot," "Sandusky Flora," and "Flora of the Oak Openings West of Toledo." In his latter years he devoted much study to tree rings, on the thesis that they might reveal evidence that could be used to predict cycles of rainfall. This work stimulated much interest, both locally and across the continent.

Living almost the life of a recluse, and abstemious to an extreme in matters pertaining to the comforts of life, Professor Moseley was quietly and unostentatiously philanthropic in numerous ways, taking much interest in, and often helping financially, students who showed promise of development, but who were handicapped by lack of financial support. It was in accord with this spirit that he willed his entire estate to aid worthy students at the institution in which he served so long.

Affiliated with a number of organizations and societies, Professor Moseley was a lifelong member of the American Society of Mammalogists, the Wilson Ornithological Club, the Michigan Academy of Science, and the Ohio Academy of Science (Secretary, 1895–1903; President, 1904).—*Charles H. Otis.*

Guy E. VanSickle

The Department of Chemistry of the University of Toledo sustained a sad and severe loss, on December 12, 1948, in the sudden death of Professor Guy E. VanSickle. His contribution to higher education in his field at the university over a period of thirty years has been of inestimable value, as has been his enrichment of the cultural and social life of the university faculty.

Professor VanSickle received his undergraduate training at the Ohio State University, Class of 1909, and continued in graduate study there to the Master's degree in 1911. He then taught chemistry in the Toledo high schools until 1918 when he was appointed Professor of Chemistry at the University of Toledo. He was a member of the American Association of University Professors, the Ohio Academy of Science, and the American Chemical Society. He was one of the founders, in 1917, of the Toledo Section of the American Chemical Society and had been, at various times, secretary, chairman and councillor. For many years he gave freely of his time and counsel as adviser to Chi Rho Nu fraternity.

Through his genial and friendly nature, his effective teaching techniques, and his willing counsel Professor VanSickle made a host of friends among his students, his associates, and his wide circle of acquaintances in Toledo. He is survived by Mrs. VanSickle and three sons, Homer, Carl, and James.—*Harold G. Oddy.*

REPORT OF COMMITTEE ON RESOLUTIONS

Be it Resolved, that the Ohio Academy of Science express to President Kenneth I. Brown of Denison University and to the local committee under the able leadership of Dr. A. W. Lindsey, its appreciation of the hospitality so freely extended and the excellent facilities furnished in this most inviting collegiate environment, which have made this, our fifty-eighth annual meeting, so pleasant and successful.

Be it further Resolved, that the Ohio Academy of Science express to Dr. Wilbur M. Tidd its thanks for his efficient services as Treasurer of the Academy, from which position he has recently resigned.

Respectfully submitted,

P. B. Sears,
W. C. Beaver,
W. C. Kraatz, *Chairman.*